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Distribution and abundance of Twites wintering in Caithness

H CLARK & R M SELLERS

The Twite is one of the commonest small seed eating passerines in Caithness in the non breeding season. Five censuses carried out in the winter months between 1992 and 1994 found between 2,136 and 6,882 birds, typically in flocks of <300 birds, occasionally up to about 1,300 birds. Their wintering range extends over some 615 km^2 of agricultural land mainly between Thurso and Wick. The principal habitats used were weedy Turnip fields, in which Charlock* Sinapis arvensis *was the main foodplant, uncut Rape, especially in 1992 when poor weather prevented the Rape crop being harvested, and Rape stubbles. The results emphasise the importance of Caithness as a wintering area for this British Red Data List species. The conservation aspects of the results are discussed.

Introduction

The Twite *Carduelis flavirostris* is one of only 2 passerines for which the British breeding population is of international importance (Batten et al 1990). Within Britain the species breeds in 2 main areas, the Peak District and southern Pennines in England and in northern and western Scotland from the Mull of Kintyre to the Western Isles and through the Highlands to the Northern Isles (Orford 1973, Sharrock 1976). Small numbers also breed in several other parts of Scotland and in Ireland and a few pairs nest in Wales. Elsewhere in Europe the species' breeding range is restricted to Norway and the Kola peninsula in northern Russia.

The Peak District population winters mainly on the east coast of England from the Humber to Kent and in the Low Countries (Davies 1987, 1988). In Scotland, Twites are virtually absent from high ground in the winter months and appear to be restricted primarily to coastal areas at this time of year (Lack 1986). Despite the obvious conservation interest in the species, many aspects of the Twite's biology remain unknown. We report here on a study of Twites wintering in Caithness, one of the more important wintering areas in Scotland.

Materials and methods

Information on the distribution, flock sizes and habitats used by Twites in Caithness in the winter months was obtained principally through 5 surveys of the area carried out on 14-15 November 1992 (a small area in the extreme south of Caithness was not covered until 16 November), 28-29 December 1992, 4-5 December 1993, 3-4 December 1994 and 29-30 December 1994, together with other observations we have made over the past 15 years and records published in the Caithness Bird Report 1983-94 inclusive. Each of the 5 surveys was carried out over 2 consecutive days, and involved checking fields and other land visible from all public roads in Caithness. Typically one day was devoted to north east Caithness (roughly north of the A882 Thurso-Wick road), and the other to the south west of the area. A number of checks made mainly along the boundary between these 2 areas

showed no evidence of a substantial redistribution of birds between one day and the next and, in the short term at least, Twites appear to return daily to favoured feeding sites. We believe, therefore, that any double counting of birds will have been minimal. Most fieldwork was done by car, but, as necessary, Turnip fields, stubbles and weedy areas were checked by foot. Twites are restless birds and, whilst not easy to locate when feeding, soon take flight revealing their presence. Twites appear to be less active in the afternoon and we found that flocks began to break up in mid afternoon as the birds went to roost. Fieldwork was, therefore, restricted to the period 0900-1400 hr GMT.

It became evident during the first survey that birds were restricted almost exclusively to fields of Turnips *Brassica napa* and Oil Seed Rape *B napus,* so, for the subsequent surveys, we attempted to survey all such fields in Caithness . Most were also covered in the first survey, but a few were undoubtedly missed; the count for the first survey will, therefore, be an underestimate. Information on the distribution of Turnip and Rape fields was kindly supplied by Mr P Miller, who, in the course of his work with the Scottish Office Agriculture and Fisheries Department, visits farms throughout Caithness. The surveys should, in principle, have given a direct estimate of the total number of Twites in Caithness, but no doubt an unknown, but small, percentage will have been missed. Weather for the surveys was generally good.

For all Twite flocks located the number of birds present was estimated and the habitat they used recorded. Twites sometimes occur in mixed flocks with other finches, buntings, etc, and, in these cases, we estimated the number of Twites from the total flock size and the proportion of Twites present.

For ringing purposes birds were caught in single shelf nets set up in Turnip or Rape fields or in 4 shelf nets set by hedges bordering these fields. Birds were attracted to the general trapping area by playing a tape recording of Twite song. The majority of the birds ringed were caught at Bruan, Killimster and Lynegar.

TABLE 1 ***Flock sizes of Twites wintering in Caithness 1992-94.***

Survey date	Mean flock size	Number of flocks of size shown				
		1-30	31-100	101-300	301-1000	>1000
14/15 Nov 92	125	10	4	3	2	0
28/29 Dec 92	344	3	4	7	4	2
4/5 Dec 93	82	12	8	6	0	0
3/4 Dec 94	101	14	9	5	2	0
29/30 Dec 94	151	5	5	8	1	0
All combined	152	44 (39%)	30 (26%)	29 (25%)	9 (8%)	2 (2%)

Results

Formation and size of flocks

Twites occur in Caithness throughout the year. In the breeding season they are well dispersed throughout the area and are rarely to be seen other than in small groups which we take to be family parties. Flocks begin to form as early as July, but it is not until late August that the majority of birds are to be found in flocks. Flocks start to break up in February and few have been recorded in Caithness after March. Flock sizes vary considerably but, in midwinter, typically number no more than about 300 birds. The distribution of flock sizes recorded in our 5 surveys is summarised in Table 1; mean flock sizes varied from 82 to 344 birds with about 40% of flocks containing ≤30 birds, about 65% ≤100 birds and 90% ≤300 birds. Averaged over our 5 surveys, about 5% of the population were in flocks of ≤30 birds, 12% ≤100, 53% ≤300 and the remaining 47% in flocks of >300. The largest flocks recorded in Caithness were 1,280 birds at Alterwall and 1,100 birds at Northfield, both in December 1992 (as part of our surveys), 1,000 birds at Gills in August 1987 (R M Sellers, unpublished observations) and 1,000 at Loch Watten in November 1990 (Caithness Bird Report 1990). The majority of flocks we recorded appeared to consist solely of Twites; the remainder were mixed flocks with Greenfinches *C chloris*, Linnets *C cannabina*, Chaffinches *Fringilla coelebs*, and, less often, Redpoll *C flammea*, Brambling *F montifringilla*, House Sparrows *Passer domesticus*, Reed Buntings *Emberiza schoeniclus* and Yellowhammers *E citrinella*. Twites were generally the single most numerous species in these mixed flocks and were one of the commonest small seed eating passerines in Caithness in the winter months.

Abundance, distribution and habitats

The results of the 5 main surveys are summarised in Table 2. Between 19 and 30 flocks were found per survey, with the total number of birds recorded varying between 2,136 and 6,882 birds. There was a marked increase in the number of birds between the first and second 1992 surveys, which were carried out 6 weeks apart, though the number of flocks increased by only one. We suspect that this increase in the number of birds was a consequence of an influx of birds. By contrast, there was only a small decrease in the number of birds between the 1994 surveys, though the number of flocks decreased by about a third.

TABLE 2 ***Numbers of Twites wintering in Caithness 1992-94.***

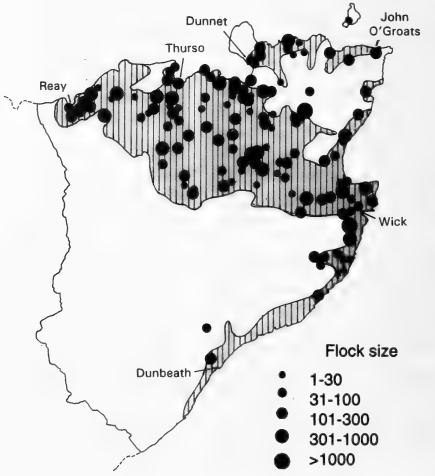
Survey date	Flocks	Birds
14/15 Nov 1992	19	2368
28/29 Dec 1992	20	6882
4/5 Dec 1993	26	2136
3/4 Dec 1994	30	3036
29/30 Dec 1994	19	2873

The winter range of Twites in Caithness is shown in Fig 1, which is based on all observations from our surveys, together with records from the Caithness Bird Report for October-March inclusive. Sightings are confined mostly to land below 200 metres above sea level and occur almost exclusively on the arable and stock rearing land between Reay, Thurso and Wick and Dunbeath. The flow country of south and west Caithness is difficult to survey, but, on the basis of fieldwork along the Causey Mire (the A895 between Georgemas and Latheron), in the vicinity of Loch More, near Broubster, between Camster

and Badlipster, near Houstry, and between Dunbeath and Braemore, we are satisfied that the absence of records from this area represents a genuine absence of birds. On the basis that the winter range coincides with that of agricultural land, as shown in Fig 1, we estimate that the area usually occupied by Twites in Caithness in the winter months is approximately 615 km^2. Only 6 sites (32%) occupied during the 14-15 November 1992 survey still held birds 6 weeks later; for the 3-4 December 1994 survey, 14 sites (48%) still held birds by the time of the next survey 4 weeks later. The majority of the sites vacated held flocks of <30 birds and/or, in the case of the 1994 surveys, were sites where stubbles had been ploughed between the 2 surveys.

The habitats from which Twites were recorded in our surveys are summarised in Table 3. The most important by far were weedy Turnip fields (Charlock *Sinapis arvensis* being the most common weed), Rape stubbles and, in 1992 especially, uncut Rape as wet weather delayed harvesting of the Caithness Rape crop in 1992 and many fields were simply left uncut, or were cut after most seed pods had spilt their contents on the ground. Small numbers of birds were recorded from a number of other habitats, including the sand dune system at Dunnet Links (dominated by Marram Grass *Ammophila arenaria*), weedy

Figure 1 ***Winter range of Twites in Caithness.*** *Shaded area shows agricultural land (after Omand 1972). Largest flock size for each site shown; all records refer to period October-March inclusive; includes data from Caithness Bird Report and special surveys.*



ground (fields, roadside verges etc) and Barley stubbles. Flock sizes were appreciably larger on Rape and Rape stubbles than on Turnips and the other habitats (Table 3). Our fieldwork has shown that Turnip fields, uncut Rape and Marram Grass are also used by some birds for roosting overnight.

We have not systematically collected information on foodstuffs but, during the course of the study, recorded Twites taking seeds of the following plants: Charlock (husked seeds of this plant were visible in the crops of many of the birds we caught), Thistle *Carduus* spp, Dock *Rumex* spp, and Rape. There is also a record from the late summer of 1992 of Twites feeding on the putting greens of Reay Golf Course where they were taking the seeds of Annual Meadow Grass *Poa annua* (J Gunn, *pers comm*).

Ringing recoveries

Despite having ringed 608 Twites in Caithness, about 37% with colour rings, only 4 have been retrapped, recovered or seen again away from where ringed. These involved an adult female ringed at Killimster, Caithness in December and found dead near Poolewe, Wester Ross (165 km WSW) the following May, a first year male ringed at Lynegar, Caithness in November and recovered on Lewis in the Western Isles (180 km W) in July 3.5 years later, a first winter female ringed at Lynegar, Caithness in January and found dead the following April at Dunbeath, Caithness (29 km SSW) and a first year male ringed at Northfield, Caithness in December and found tangled in sheep's wool at Hempriggs, Caithness (2 km SSE) in June 2.5 years later. The third and fourth of these seem to have been birds which bred and wintered in Caithness, whereas the first and second were ones which bred in north west Scotland and wintered in Caithness.

Discussion

Population size

The Twite is one of the most abundant small seed eating passerines which winter in Caithness with a population varying between about 2,000 to 3,000 birds in typical years and up to 7,000 birds in exceptional years in the period 1992-94 according to our surveys. The Winter Atlas (Lack 1986) gives an estimated British and Irish midwinter population of 100,000-150,000 birds (based on a breeding population of 20,000-40,000 pairs and "a net input of 50,000-100,000 birds by December"). Birds wintering in Caithness thus represent roughly 2% in typical years, and up to 5% in exceptional years, of the British wintering population, emphasising the importance of the area for Twites.

The first, third, fourth and fifth of our surveys found roughly the same number of birds (2,000-3,000) and provide a baseline against which future changes can be compared. We found a substantial increase in the number of birds present between the first and second 1992 surveys when food was unusually abundant. We suspect that this was the result of an influx of birds from outside Caithness, or passage birds staying to winter.

Flock of Twites in Caithness typically hold up to 300 birds but, on occasion, numbered over 1,000 birds. These large flocks appear to be amongst the biggest ever recorded in Scotland (Thom 1986), but flocks up to 2,500 strong have been seen on the Wash (Davies 1987, 1988) and up to 3,000 on the Continent (Cramp & Perrins 1994).

Habitats

In Caithness, Twites are confined almost

TABLE 3 ***Habitats used by Twites wintering in Caithness 1992-94.***

Survey date	Habitats											
	Turnips		Uncut Rape		Rape stubble		Weedy ground		Marram		Barley stubble	
No of flocks:												
14/15 Nov 92	10	(53%)	4	(21%)	5	(26%)	0		0		0	
28/29 Dec 92	5	(25%)	15	(75%)	0		0		0		0	
4/5 Dec 93	13	(50%)	0		9	(35%)	2	(8%)	1	(4%)	1	(4%)
3/4 Dec 94	20	(67%)	2	(7%)	5	(17%)	2	(7%)	1	(3%)	0	
29/30 Dec 94	14	(74%)	0		3	(16%)	1	(5%)	1	(5%)	0	
All dates	62	(54%)	21	(18%)	22	(19%)	5	(4%)	3	(3%)	1	(1%)
No of birds:												
14/15 Nov 92	740	(31%)	1185	(50%)	443	(19%)	0		0		0	
28/29 Dec 92	820	(12%)	6062	(88%)	0		0		0		0	
4/5 Dec 93	559	(27%)	0		1179	(57%)	108	(5%)	70	(3%)	150	(7%)
3/4 Dec 94	1034	(34%)	210	(7%)	1684	(55%)	33	(1%)	75	(2%)	0	
29/30 Dec 94	2240	(78%)	0		530	(18%)	100	(3%)	3	(0.1%)	0	
Total	5393	(31%)	7457	(43%)	3836	(22%)	241	(1%)	148	(1%)	150	(1%)
Mean flock size	87		355		174		48		49		150	

exclusively to farmland in the winter months, the important habitats being weedy Turnip fields, Rape stubbles and, mainly in 1992, fields of uncut Rape. Rape is a new crop in Caithness. The birds were exploiting spring sown Rape, which, in 1991, amounted to only 5 ha rising to 491 ha in 1992, the increase apparently being due to a change in agricultural subsidies. Over the same period, winter sown acreage decreased from 234 ha in 1990/91 to 35 ha in 1991/92. We have no figures for seasons before 1991 but understand that the areas sown with Rape were extremely small. As noted above, much of the 1992 spring sown crop was not cut, or was cut late, because of wet weather at harvest time; the abundance of Rape seed in the winter of 1992/93 in Caithness was, therefore, wholly novel, but our observations serve to highlight the ability of Twites to exploit new food sources when they become available. Spring sown Rape appears to be establishing itself as a crop in Caithness with 274 ha in 1993 and 488 ha in 1994, and, even if the crop is successfully harvested, Rape stubbles have the potential to supply a significant part of the species' winter food requirements. Weedy Turnip fields, however, appear to be the traditional wintering habitat and our preliminary observations suggest that they are also important in the Dornoch Firth and Beauly Firth areas. In addition, Twites are recorded as using Turnip and stubble fields in north east Scotland (Buckland, Bell & Picozzi 1990), weedy Turnip fields in Morayshire (Cook 1992) and, on Islay, as using stubbles as well as taking small seeds from farmland weeds and maritime flowers (Elliot 1989).

Origins

Although there are only 4 ringing recoveries available, they suggest that the Caithness wintering population is drawn from both the local breeding population and that of north west Scotland. There is a passage of Twites on Fair Isle in both autumn and spring (Dymond 1991) as well as a number of ringing recoveries showing movements between Shetland and Orkney. We consider it likely that some birds from the Northern Isles also winter in Caithness. There appears to be a small passage across the northern North Sea. Small numbers of Twites are seen each year on North Sea oil rigs (North Sea Bird Club Reports) and it is tempting to see this as evidence that Norwegian birds move into Scotland, though they could be Scottish birds moving to the Continent. This is supported by the recovery of a bird ringed on Fair Isle in July 1953 on a ship off Heligoland the following October. By contrast, an extensive ringing programme in Norway in the 1960s failed to generate a single recovery anywhere in Britain, though there were over 50 along the North Sea coast from Denmark to France (Bernbhoft-Osa 1965). On the evidence currently available, we suggest that the Caithness population is drawn almost entirely from the northern Scottish breeding population.

Conservation

The Red Data Book for birds in Britain (Batten *et al* 1990) stresses the importance of saltmarsh as wintering habitat for the Twite and that among the main threats to the species' survival are loss of habitat and a reduction in the food supply at wintering sites. These comments appear to be based on the English population for which the main foodplants in winter are Marsh Samphire *Salicornia* spp and Sea Aster *Aster tripolium* . The former does not occur in Caithness, nor in several of the other important wintering areas in Scotland, and the latter is relatively scarce in Caithness and is restricted to coastal cliffs (Perring & Walters 1990, Bullard *et al* 1977)

which Twites do not appear to use in the non breeding season. Our results suggest that the weeds of Turnip fields, especially Charlock, are important in Caithness and that this may well be the case in several other parts of Scotland. The acreage of Turnips, and, by implication, that of the associated weed flora, has decreased by a factor of about 8 over the past half century (Table 4), and this trend gives some cause for concern as to future winter food supplies in the area. A similar trend is apparent in Sutherland (Omand 1991). Our results show that Twites can adapt to other foodstuffs if circumstances permit. The abundance of Rape seed in Caithness in 1992 was probably unique, though the continued availability of Rape stubbles may be important. It is clear that the abundance of Turnip fields and Rape stubbles in Caithness needs to be monitored carefully and that further studies are required elsewhere in the main Scottish wintering areas to define the habitats used and the extent to which these are under threat.

Scottish Twites have been described as largely sedentary (eg Batten *et al* 1990, Jardine & Reid 1993), and, whilst this is partly true, evidence is mounting that some do move and that the pattern of these movements may be quite complex. The breeding and winter distributions show a substantial redistribution of birds between the breeding and non breeding seasons (Jardine & Reid 1993, and Lack 1988), and the results of this study are evidence of movements across the north of Scotland between the west coast and Caithness. The conservation of these birds thus depends on protecting both the breeding areas in north west Scotland and wintering grounds in Caithness.

TABLE 4 ***Turnip acreages in Caithness over the past half century .***[a]

Date	Area of Turnips (ha)
1937	3662
1961	2743
1971	1121
1983	707
1991	439[b]

a Data from Scottish Office Agriculture & Fisheries Department

b After 1983 Turnip fields < 2 ha did not have to be reported; this figure thus slightly underestimates the true figure

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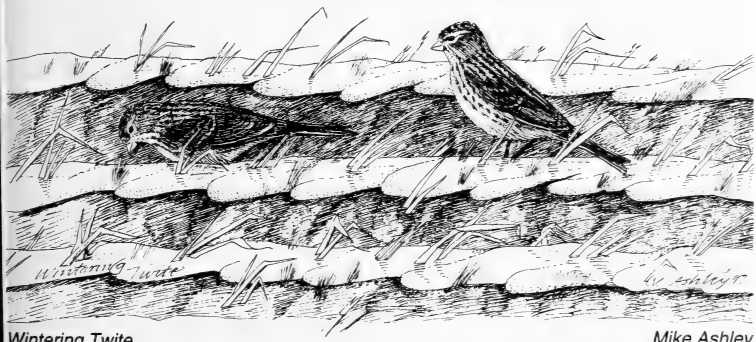


Wintering Twite *Mike Ashley*

The status of the Gannet in Scotland in 1994-95

S MURRAY & S WANLESS

A census of all the Gannet colonies in the east Atlantic was carried out in 1994-95. This paper summarises the results from all the Scottish gannetries and compares them with the last major census in 1984-85. Scotland remains the stronghold of the Gannet with 12 colonies and a total population of 167,407 apparently occupied sites representing 61.1% of the east Atlantic population. Numbers were divided very unevenly between the colonies with St Kilda, the Bass Rock and Ailsa Craig together holding 76% of the Scottish population and 47% of the east Atlantic population. Since 1985 Gannets have bred at least once on Rockall (1992) and colonised Scotland's first mainland gannetry at Troup Head (1988). The colony on the Shiant Isles was short lived. The Scottish population increased at an average rate of 2.4% pa between 1984-5 and 1994-95. Sule Stack was the only colony which did not increase over the period. Rates of increase at the other colonies varied considerably but, in general, were highest at recently founded colonies.

Introduction

At the time of the last comprehensive census of Gannets *Morus bassanus* in 1984-85, there were 12 gannetries in Scotland. The Scottish population was estimated at 132,100 occupied sites which represented almost 60% of the total for the east Atlantic and about 50% of the world population (Murray & Wanless 1986, Wanless 1987). Numbers at most colonies were increasing and the Scottish population was estimated to have shown an average rate of increase of 2.0% per annum (pa) between 1969 and 1985. We coordinated another complete survey of east Atlantic gannetries in 1994-95 and this paper details the counts from all the Scottish colonies and compares them with the results of the 1984-85 census.

Methods

The locations of the colonies are shown in Figure 1. We carried out aerial surveys of St Kilda, Sule Stack, Sula Sgeir, the Flannan Isles and the Bass Rock in 1994, and Ailsa Craig and the Scar Rocks (also referred to as the Scare Rocks) in 1995. The remaining colonies were counted by other observers who are acknowledged below.

The 1994-95 survey was carried out using similar methods to those adopted in 1984-85 with colonies counted either from field counts made from the land or sea, or from photographs (mainly transparencies rather than prints) taken from the land, sea or air. For a few colonies such as Bass Rock, Hermaness and St Kilda different sections of the colony were counted using different methods. Details of the various techniques

Figure 1 ***The distribution of gannetries in Scotland 1994-95. The colonies are identified by the following numbers: Scar Rocks (1); Ailsa Craig (2); St Kilda (3); Rockall (4, not known if occupied in 1994/95); Shiant Isles (5 abandoned); Flannan Isles (6); Sule Sgeir (7); Sule Stack (8); Foula (9); Hermaness (10); Noss (11); Fair Isle (12); Troup Head (13); and the Bass Rock (14).***

used to count Scottish gannetries, and the problems associated with these methods are given in Murray & Wanless (1986).

For counts made from photographs, the only practical counting unit was the apparently occupied site (AOS, a site occupied by one or 2 Gannets, irrespective of whether nest material was present). Sites which were clearly occupied by nonbreeders were excluded whenever possible. In most field counts the unit was the apparently occupied nest (AON, one or 2 birds at a site with some nest material present). Sites with a chick but no obvious nest were included in this category. For both count units we, or other observers, judged that it was always possible to distinguish directly whether a pair or a single bird was present and hence no correction for this effect was necessary for totals of either AOS or AON (cf Nelson 1978). The only exception to this was J B Nelson's count of the Bass Rock for which full details are given in the section dealing with this colony.

We emphasise that neither count unit provides an estimate of the number of breeding pairs, nor is it strictly correct to equate occupied sites with pairs, as some sites may be held by a single bird for at least a year (Nelson 1978). The unavoidable lack of standardisation of count units across colonies also makes it impossible to calculate a grand total for Scotland in terms of a common unit. Our estimate of the Scottish population, and the east Atlantic total, is, therefore, a combination of totals of apparently occupied sites at the majority of colonies and a few counts of nests. No correction factors were applied to either unit and, for convenience, the grand total is expressed in terms of apparently occupied sites.

Nelson (1978) recommended that counts be made in June or July. These guidelines were followed at all colonies, except St Kilda, where the count was carried out in mid May to take advantage of a spell of fine, settled weather, and Ailsa Craig and Scar Rocks where the aerial survey was delayed until early August so as to ensure that there was no disturbance of Guillemots *Uria aalge*.

Where possible, counts for a colony are presented in terms of its constituent sections to facilitate future comparisons of population changes. Average rates of change for each colony were calculated using the equation:

$$P_2/P_1 = (1 + r)^t$$

where r is the rate of population change, P_1 is the nest or site count in 1984 or 1985, P_2 is the nest or site count in 1994 or 1995 and t is the number of years between the 2 counts. Counts made up to 1985 are summarised in Fisher & Vevers (1943, 1944) Nelson (1978) and Murray & Wanless (1986). Only subsequent counts are referenced in this paper.

Results

There were 12 active gannetries in Scotland in 1994-95 (Fig 1). Since the 1984-85 survey, the first colony on mainland Scotland was established at Troup Head (Matthews & North 1989) and the first recorded breeding on Rockall occurred in 1992 (Belaoussoff 1993). The lone nest site on the Shiant Isles was abandoned around 1987. The 1994-95 counts and current population trends are summarised below for each of the Scottish gannetries.

Scar (Scare) Rocks

An aerial survey was carried out on 5 August 1995. The colony was divided into 4 sections (Fig 2) and the 2 independent counts gave an average total of 1952 AOS with observer variation being 7.4% of the mean. The quality of the photographs of the north cliff and the plateau was excellent but only moderate for the west stack and slope. There was a substantial increase in numbers between 1984 and 1995 (Table1). The change from a land based field count of AON in 1984 to an aerial survey of AOS in 1995 will have exaggerated the rate of increase particularly since some areas of the colony are difficult to see from the land (P Collin pers comm). For these reasons, the calculated increase of 154% over 11 years, an annual rate of 8.8% pa, must be regarded as an overestimate.

Figure 2 ***Counting divisions used to census the Scar Rocks in 1995. Counts of the number of AOS in each section are also shown.***

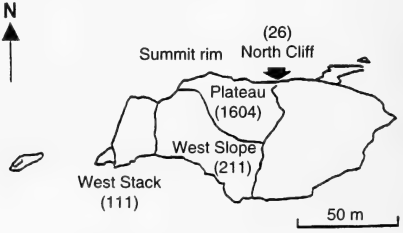


Table 1 ***Counts of the gannetry on the Scar Rocks 1984-1995.***

Year	Field counts (nests)	Aerial survey (occupied sites)	Source
1984	770		Muray & Wanless (1986)
1987	830		Dickson (1992)
1989	700		Nelson in Dickson (1992)
1994		1200+	P N Collin pers comm
1995		1952	This survey

Ailsa Craig

The count was made from aerial photographs taken on 5 August 1995. Weather conditions were ideal and the standard of the resulting slides was excellent. For the count the colony was divided into 19 sections (Fig 3) based on 23 sections originally used by Gibson (1951) and Wanless (1979). A few sections had to be amalgamated, either because increases in adjacent sections made it difficult to distinguish the original boundaries, or because of differences in viewing angle between the previous sea based censuses and the 1995 aerial survey. Two independent counts were made of the colony, the average of which gave a total of 32,455 AOS (Table 2) and observer variation was 5.0% of the mean. This represented an increase of 42% (3.6% pa) over the 1985 count of 22,811 AON. However, although the colony has undoubtedly shown a substantial increase over the period, differences in methodology and count units used in the 2 surveys are likely to have exaggerated the magnitude of the change.

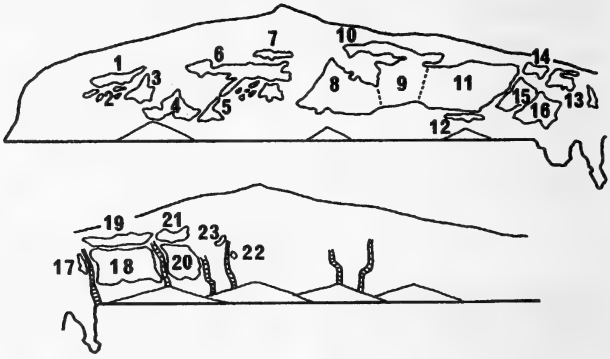
St Kilda

Full details of the methodology and results for the St Kilda survey are given in Murray & Wanless (1996) but, in brief, an aerial

Table 2 ***Counts of the number of occupied Gannet sites on Ailsa Craig on 5 August 1995. Sections are shown in Fig 3 and are based on those used by Gibson (1951) and Wanless (1979).***

Section	Count (AOS)
1	946
2	187
3	441
4,5	1877
6	2097
7	954
8	4300
9,10,11	11959
12	140
13,14	1994
15	993
16	1270
17	21
18	908
19	3410
20	531
21	250
22	0
23	177
Total	32455

Figure 3 ***Counting divisions used to count aerial photographs of Ailsa Craig in 1995.***



photographic survey of the gannetry was carried out on 15 May 1994. Counts of Stac Lee and Stac an Armin were made entirely from aerial photographs; one section on Boreray was counted from a photograph taken from the sea and the remaining sections were counted from aerial photographs. Photographic coverage of the stacs was complete but a few sites on Boreray (c 1.4% of the total) were thought to have been missed and the count was adjusted accordingly.

The overall total for St Kilda was 60,428 AOS with 14,660 AOS (24%) of the total on Stac Lee, 12,950 AOS (21%) on Stac an Armin and 32,818 AOS (54%) on Boreray.

These figures represented overall increases since the last survey in 1985 of 20.7%, 8.4%, 9.3% and 33.0% respectively, equivalent to average annual rates of 2.1% pa, 0.9% pa, 1.0% pa and 3.2% pa. While some, but not all, of the increase on Boreray was thought to be due to differences in count methodology, the increases on the stacs, and some parts of Boreray, were undoubtedly real and we concluded that the St Kilda gannetry had probably shown a sustained increase of c 0.9% pa over the last 35 years.

Rockall

No observations were made in 1994-95 but a single nest containing an egg was found on 19 June 1992 (Belaoussoff 1993). Although Gannets had previously been seen on the rock (review in Bourne 1993) this was the first recorded breeding.

Shiant Isles

No nests were found during a visit to the islands on 3-4 July 1995, but a single bird was seen ashore close to the Garbh Eilean site (J Love pers comm). During the 1985 survey, a single bird was recorded on a nest on Eilean Mhuire and there was another well built nest on Garbh Eilean. Only the Garbh Eilean site was occupied in 1986 and no Gannets were recorded ashore in May 1992 (S Murray pers

obs). It therefore appears that, after a period of occupancy lasting from 1979 to 1986, during which there was no definite breeding record, Gannets have, for the time being at least, given up their attempt to colonise the Shiant Isles.

Flannan Isles

The count was made from aerial photographs taken on 15 July 1994. The colony consists of 6 separate subgroups on the island of Roareim and its islets (Fig 4). The quality of the slides was high and the average of 2 independent counts gave a total of 1,438 AOS with an observer variation of 4.7% of the mean. No birds were recorded ashore on Eilean a Gobha during the 1994 survey, but Gannets were present, but not apparently nesting, on the island's east cliffs during visits in 1988 and 1992 (Table 3).

Previous counts of the colony have all been made from field counts supplemented by land or sea based photographs (Table 3). In 1992, landing was limited to the edge of Sgeir an Eoin resulting in a probable underestimate of this sub colony and the main colony. Although it is clear that the gannetry on the Flannan Isles has increased greatly between 1985 and 1994, the change in count methodology will undoubtedly have resulted in the overall increase and average rate of change, 545% and 23.0% pa respectively, being overestimated.

Sula Sgeir

The count was made from aerial photographs taken on 15 July 1994. Full details of the survey are given in Murray & Wanless (1994). The colony was divided into 8 sections and the standard of the count was considered to be high. The average of 2 independent counts was 10,440 AOS (Table 4) with an observer variation of 0.2% of the mean. Count

Figure 4 ***Locations of sub colonies of Gannets on the Flannan Isles. All the subcolonies except the one on Eilean a Gobha were occupied in the 1994 survey. Counts of the number of AOS in each section are also shown.***

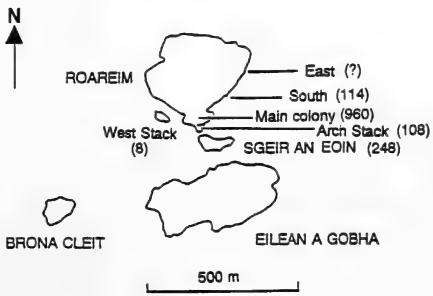


Table 3 ***Counts of the gannetry on the Flannan Isles 1985-94. Locations of the various sections are shown in Fig 4.***

	16 June 1985[1] (nests)	12 June 1988[2] (occupied sites)	24 May 1992[3] (nests)	15 July 1994[4] (occupied sites)
a) Roareim				
East		2	c6	?
South			23	113
Main colony	223	384	539+	960
Arch stack			23	107
Sgeir an Eoin		26	84+	248
West stack		4	4	8
b) Eilean a Gobha				
East		c50[5]	c55[6]	0
Total	223	416	734+[7]	1438

Notes
1. *Counted from photographs taken from the land supplemented by land based field counts*
2. *Counted from photographs taken from the land supplemented by land based field counts (M Tasker & D Rothe, pers comm)*
3. *Land based field counts (S Murray, unpublished)*
4. *Aerial photographs*
5. *Count unit birds*
6. *Count unit occupied sites*
7. *Includes 55 occupied sites*

methodology for the 1985 and 1994 surveys was identical. The number of AOS increased by 14% over the period at an annual rate of 1.5% pa. There was no evidence of any expansion in area of the gannetry and the increase appeared to have occurred mainly in sections 3 and 4 (Table 4).

Sula Sgeir is the only Scottish colony where young Gannets, known as gugas, are still taken for food. The current licence, which is issued by the Scottish Office Agriculture, Environment and Fisheries Department, is for 2,000 young per year but the number of gugas taken is not closely monitored, neither

is there any check on the number of chicks lost during the hunt. Counts of corpses in photographs of gugas prior to off loading from Sula Sgeir (Beatty 1992) suggest that, at least in some years, the number killed may be greater than the licence.

Sule Stack

The count was made from aerial photographs taken on 15 July 1994. Complete coverage of the rock was achieved and the standard of photographs was excellent. The colony was divided into 8 sections (Fig 5) and 2 independent counts gave an average total of 4,888 AOS with an observer variation of 2.8% of the mean. The North Rock remains uncolonised, while the South Rock had only 73 occupied sites but large numbers of non breeders. Although count methodology in 1985 and 1994 was directly comparable, the 1985 photographs were of only moderate standard. The possibility exists that the 17% decrease between 1985-94 was at least partly due to the 1985 total being too high (Table 5), but Sule Stack appears to be the only Scottish gannetry not to have increased in size over the last decade.

Foula

A total of 600 AOS was counted from the land and sea by R W Furness on 2 and 16 July 1994. The colony has increased by 186% over the last 10 years at an average rate of 11.1% pa. Additional counts during the period were 210 AOS/140 AON (1984), 124 AON, 151 AON, 158 AON, 220 AON and 280 AON 1987-1991 respectively (data from Seabird Colony Register).

Hermaness

The numbers of AON were counted from the land by H Towll (SNH) between 12 and 18 July 1994. Hidden areas were photographed

Table 4 ***Counts of the Sula Sgeir gannetry in 1985 and 1994. Count sections are shown in Fig 3 of Murray & Wanless (1986).***

Section	Occupied sites 1985	1994	% Change
1	858	879	2.4
2	584	384	-34.2
3	2394	2954	23.3
4a	*)	2038	.*)
4b	2031)	1154	57.2)
5	136	0	-100.0
6	1532	1353	-11.7
7	1541	1680	9.0
Helipad	68	0	-100.0
Total	9143	10440	14.2

** What was Section 4 in 1985 became 4a and 4b in 1995*

from the sea on 22 August and AOSs counted off the slides. Following Murray (1992), the colony was divided into 18 sections and the figures given in Table 6 are an average of 3 replicate counts by the same observer. A total of 10,640 AON was counted from the land and 1,353 AOS were counted from the photographs (Table 6) which gives an overall total of 11,993 AON/AOS. The 1984 total was originally given as 8,063 AON but this figure was subsequently revised to 8,506 AON (Murray 1992). Thus, over the last 10 years, the colony has increased by 25%, an annual average rate of 3.5% pa.

During the period 1969-84, the Gannet population on Hermaness showed marked fluctuations. As the colony is notoriously difficult to count, it was unclear whether these variations reflected real changes in numbers or were due to counting error. In contrast there has been no evidence of fluctuations over the past 10 years with 9,904 AON recorded in 1986 (S. Wanless & M. Heubeck unpublished) and 10,057 AON in 1991 (Murray 1992). Count methodology was standardised in 1991 (Murray 1992) which suggests that the earlier variability was due mainly to differences in the way that counts were made.

Figure 5 ***Counting divisions used to census the gannetry on Sule Stack in 1994. Counts of the number of AOS in each section are also shown.***

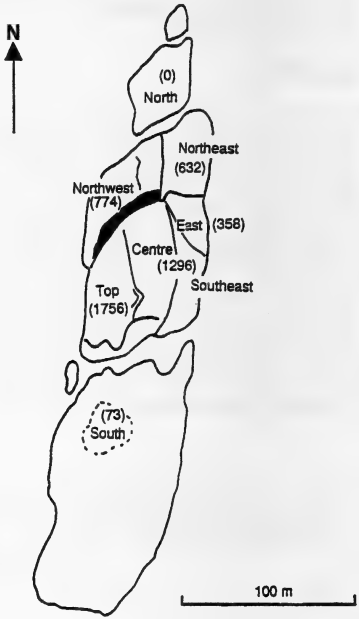


Table 5 ***Comparison of the number of occupied Gannet sites in sections of the Sule Stack gannetry in 1985 and 1994.***

Section	15 July 1985	15 July 1994	% change
North	0	0	0
North west and north east	2240	1406	-37
East, south east, centre and top	3590	3409	-5
South	50	73	46
Total	5880	4888	-17

Table 6 ***Counts of the Hermaness gannetry in 1994. Data supplied by SNH. The sections are shown in Murray (1992).***

Section	Land count (nests)	Sea count (occupied sites)
Rumblings East	736	-
Vesta Skerry East	1381	-
Vesta Skerry West	-	623
Humla Stac North	251	-
Humla Stac West	251	-
Humla Stac Southwest	0	-
Humla Houl North	133	-
Humla Houl South	435	-
Burra Stack East	335	-
Burra Stack West	-	238
Clingra Stack	207	-
Neap North Face	-	492
Neap-Soorie	3096	-
Soorie-Saito	1799	-
Saito	1509	-
Soorie Geo North Stack	19	-
Soorie Geo South Stack	35	-
Neapna Stack	453	-
Total	10640	1353
Overall total	11993	

Noss

In 1994, complete land counts were made on 18-20 June and 17 July respectively and 2 replicate sea counts were carried out on 30 June by S Smith and C Barton (SNH). The methods are described in Murray & Wanless (1992) and, for both land and sea counts, the count unit was apparently occupied nests. The colony was estimated to contain 7,310 AON (Table 7). In 1984 the colony was estimated to contain 5,231 AON. Subsequent counts have been 7,218 AON (1989), 6,730 AON (1991) and 6,856 AON (1992) although the 1989 figure is now thought to be an overestimate due to counting error (Murray & Wanless 1992). Numbers have increased steadily over the last 10 years with the colony showing an increase of 40% at an average annual rate of 3.4% pa.

Fair Isle

The 1994 counts of 825 nests was made on 13 June by G Thompson, Fair Isle Bird Observatory Trust. Most of the colony was

Table 7 ***Counts of the Noss gannetry in 1994. Values for land counts are the averages of 2 surveys carried out 18-20 June and 17 July respectively; values for sea counts are averages of 2 counts carried out on 30 June. Data supplied by SNH.***

Section	Land count (nests)	Sea count (nests)	Total (nests)
Cradleholm	0	1	1
Holmoless	91	17	108
Holmoless to Geordies Hole	1569	-	1569
Geordies Hole	49	-	49
Rumblewick	223	-	223
Rumblewick Face	162	-	162
Cuddacks Geo	-	-	0
Noup South	2659	-	2659
Noup East	-	517	517
Noup North	817	93	910
The Rump	560	213	773
Rump North	297	42	339
Geo Heogatoug	-	-	0
Total			7310

counted from vantage points on the land but part of the Inner Stack of Skroo was counted directly from the sea (Table 8). The number of nests rose from 138 in 1985 to 975 in 1995, an overall increase of 600% and an average annual rate of 21.6%. Nest counts between 1986 and 1993 were 258, 304,488, 676, 643, 687, 781 and 764 respectively (Riddiford 1993, Seabird Colony Register).

Troup Head

The first definite breeding record for Troup Head was in 1988, although the colony could have been established in 1987 (Matthews & North 1989). Full details of changes in numbers, breeding success and breeding chronology for the colony for the period 1988

Table 8 ***Counts of the Fair Isle gannetry in 1994. Dats supplied by Fair Isle Bird Observatory Trust.***

Section	Count (nests)
Outer Stack	219
Inner Stack	66
Yellow Head	34
Dronger	77
North Felsigeo	285
Toor 'o' da Ward Hill	82
Matchi Stack	30
Kame 'o' Guidicum	32
Total	825

to 1995 have been summarised by Wanless *et al* (1996) but, in brief, the number of nests increased by 105% from 5 in 1988 to 530 in 1995, a spectacular rate of increase averaging 64% pa.

Bass Rock

Two counts were made in 1994. One was by J B Nelson on 13 July using the same methods as in 1984, ie mainly from photographs taken from the sea and land with areas which were inadequately covered estimated by eye, using either a comparable area of counted birds or relying upon previous knowledge of the area. Counts were made of the number of birds and these were converted to occupied sites assuming a single bird to pair ratio of 10:1. It was considered possible that the corrected total of 27,293 AOS underestimated the actual total by c 10% and, thus, that the total was around 30,000 AOS. The other survey was made by ourselves from aerial photographs taken on 11 July (Murray & Wanless 1995). The colony was divided into 10 sections (Fig 6). The standard of the slides was so high that, for the majority of the colony, it was possible to separate sites with and without nest material. We, therefore, produced totals in terms of both AOS and AON (Table 9). The average of the 2 counts of AOS indicated a total of 39,751 AOS and an observer variation of 2.1% of the mean, substantially higher than Nelson's total. One reason for this difference is likely to be that we included more non breeding and loafing birds. Typically, non breeders leave a colony during an aerial survey but, during the 1994 census of the Bass Rock, it was clear that, particularly along the landward edge of the colony

Figure 6 ***Counting divisions used to census the gannetry on the Bass Rock in 1994.***

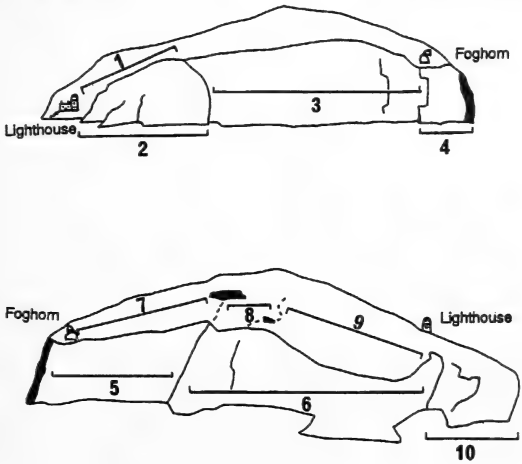


Table 9 ***Counts of numbers of nests and occupied sites on the Bass Rock on 11 July 1994, and 1 and 11 June 1985. Count sections are shown in Fig 6.***

Section	Count[1] (nests)	Count[1] (occupied sites)	% Nests	Count[2] (occupied sites)	Average (occupied sites) 1994	Average (occupied sites) 1985	% change in 1994
1	2677	2888	92.7	2585	2737	1227	123
2	553	652	84.8	637	645	320	102
3	5749	6472	88.8	7261	6867	3436	100
4	538	588	91.4	637	613	505	21
5	671	1000	67.1	1052	1026	1909	-46
6	1594	2009	79.4	2229	2119	1560	36
7	6718	7799	86.1	7972	7885	4185	88
8	3382	3712	91.1	3548	3630	2707	34
9	11068	12197	90.7	13105	12651	5371	136
10	1447	1583	91.4	1573	1578	369	328
Total	34397	38900	88.4	40599	39751	21589	84

Notes
[1]Counts made by S Murray
[2]Counts made by S Wanless

(sections 7-9), very few birds were disturbed and it was difficult to separate such individuals from true site holders. However, a second reason for the discrepancy could be that the aerial survey provided better coverage of the colony, thus reducing the chances that sections were missed. The nest count indicated a total of 34,397 AON (Table 9). Comparing this figure with the appropriate count of AOS suggested that 88.4% of AOS were in fact AON. This value should be regarded as a maximum because, while there were few problems distinguishing nests in cliff face sections (sections 2-6), it was harder to identify nests in some of the cliff top areas (sections 1, 7-10).

In 1984, Nelson (in Murray & Wanless 1986) estimated that there were 18,162 AOS on the Bass Rock. Comparing this figure with his 1994 total indicates an increase of 50%, an annual rate of 4.2% pa. Bearing in mind that the 1994 total may have been an underestimate (see above) these changes are likely to be minimum values. Comparison of our 1985 aerial survey in which 21,589 AOS were counted, with the 1994 total, indicates an even more spectacular increase of 84%, an average annual rate of 7.0% pa. Inspection of changes in each of the 10 sections indicated that numbers increased in 9 of them, the only exception being section 5 (Fig 6, Table 9) which is an area of steep, clean rock with comparatively few sites. The most obvious and spectacular expansion of the colony occurred on the northwest slope (section 9) but marked increases in colony extent were also apparent in sections 1, 3, 7 and 10. Comparison of the 1994 nest count with the 1985 site count indicated an increase of at least 59% at an average annual rate of 5.3% pa.

Total numbers in Scotland

The counts documented above were combined to provide an estimate of the total Scottish population in 1994-95. Where there were totals for both years such as on Fair Isle and at Troup Head we took the later count. For the Bass Rock, for which there was considerable variation between the 2 independent counts (see above), we used the nest count from the aerial survey as this was considered to have the lowest error associated with it. The overall total for colonies counted using AOS was 113,177, the total for those counted using AON was 54,230 (Table 10). Combining these figures and, for convenience, expressing the total as the number of AOS, gave a grand total of 167,407 AOS. Numbers were divided very unequally between the 12 colonies with St Kilda, the Bass Rock and Ailsa Craig together holding 76% of the total. In 1984/85 the Scottish population was estimated at 132,100 AOS (Murray & Wanless 1986). Comparing the 1994/95 total with this value indicates that numbers increased by 27% at an average rate of 2.4% pa.

Discussion

Compared with many other seabird species, Gannets are relatively straightforward to count, being large and conspicuous, and nesting in well defined but not excessively dense groups. Nevertheless, it is inevitable that some of the observed changes in numbers will be due to counting or sampling errors rather than actual changes in abundance and variations in count methods, dates or times between the totals being compared can all contribute to counting errors (Nelson 1978). A further source of bias stems from the tendency of individual observers to count consistently high or low (Harris & Lloyd 1977).

Table 10 ***Summary of counts of Scottish gannetries in 1994-95 and changes since the 1984-85 survey. See text for details. The possible colony on Rockall was not checked in either year.***

	Count			% change	
Colony	AON	AOS	% Scottish total	overall	pa
Scar Rocks		1952	1.2	154	8.8
Ailsa Craig		32456	19.4	42	3.6
St Kilda		60428	36.1	21	2.1
Shiant Isles		0	0	abandoned	
Flannan Isles		1438	0.9	545	23.1
Sula Sgeir		10440	6.2	14	1.5
Sule Stack		4888	2.9	-17	-2.1
Foula		600	0.4	186	11.1
Hermaness	10640	1353	7.2	25	3.5
Noss	7310		4.4	40	3.4
Fair Isle	975		0.6	600	21.6
Troup Head	530		0.3	colonised	
Bass Rock	34397		20.5	59	5.3
Total	53852	113555			
Grand total	167407			27	2.4

This effect was highlighted in our replicate counts where SW consistently obtained higher totals than SM, even though the counts were made under identical conditions. The mean (±SD) observer variation was 3.3±2.3% (n = 7 comparisons) However, while these potential errors should be borne in mind, we consider that in many cases the error of any colony counts is likely to be below 5% and, in most cases, below 10%. With an inter census interval of approximately 10 years, small, but consistent, annual changes in numbers of 2-3%, (the rate of increase typical of the Gannet (Nelson 1978)), result in overall numerical changes of the order of 22-34% which is well within the accuracy of counts at individual colonies.

The results of the 1994/95 east Atlantic Gannet survey show that the sustained increases in both abundance and range which have been recorded this century have continued over the last 10 years (Gurney 1913, Fisher & Vevers 1943, 1944, Cramp *et al* 1974, Nelson 1978, Wanless 1987). Numbers increased by 23% from 223,400 AOS in 1984/85 to 273,803 AOS in 1994/95, an average annual rate of 2.0% pa (Wanless

1987, this study). The Gannet's range has extended south with the bizarre record of a pair building a nest on a yacht at Port Frioul in the Mediterranean in 1993 (Fernandez & Bayle 1994) and east into Russia with the establishment of a colony on Kharlov, one of the islands in the Seven Islands Reserve off the Kola Peninsula (Y V Krasnov pers comm). However, Scotland remains the species' stronghold in the east Atlantic, both in terms of the number of active colonies (35% of the total) and population size (61%) (Table 11).

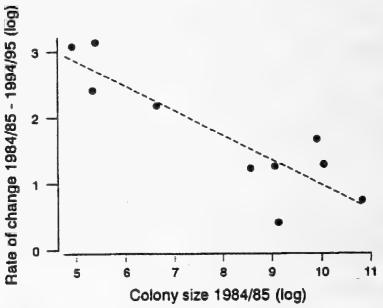
Except for Sule Stack and the nest sites on the Shiant Isles which have been abandoned, counts of every Scottish gannetry were higher in 1994/95 than in 1984/85. There was no evidence that the reduction in Sandeel *Ammodytes marinus* stocks around Shetland during the 1980s (Kunzlik 1989) had any impact on the gannetries there, even though this fish is sometimes an important prey item for Gannets during the breeding season (Martin 1989). There was, however, considerable variation between colonies in average rates of change with values being significantly higher at small colonies compared with large ones (Fig 7). Nelson (1978) calculated that the intrinsic rate of increase for the Gannet on the Bass Rock in the 1960s was about 3% pa. Assuming that current vital rates for the species are similar, this suggests that there is net immigration to colonies containing fewer than about 1,000 AOS.

Table 11 ***Summary of results from the 1994-95 east Atlantic Gannet survey.***

Country	Number of colonies	% total	Total AOS/AON[1]	% total
Scotland	12	35.3	167407	61.1
England	1	2.9	1631	0.6
Wales	1	2.9	26277[2]	9.6
Channel Islands	2	5.9	5478	2.0
Ireland	5	14.7	29948[3]	10.9
France	1	2.9	11628	4.2
Norway	5	14.7	3654	1.3
Faroes	1	2.9	2340	0.9
Iceland	5[4]	14.7	25437	9.3
Russia	1	2.9	3	0.00
Total	34		273803	

Notes: [1] *Data for Norway and Iceland are from Barrett & Folkestad (1996) and Gardarsson (1995) respectively. Counts for other areas were provided by RSPB, M G Hill, O Merne, P G H Evans, F Siorat, B Olsen, Y V Krasnov and ourselves*
[2] *Total considered a minimum due to imcomplete photo coverage*
[3] *No count available for Clare Island. Current status is unknown, but 7 to 9 individuals recorded in 1996(O Merne pers comm)*
[4] *Westmanns considered to be one colony*

Figure 7 ***Relationship between the average annual rate of change in numbers between 1984-85 and 1994-95 and the size of the gannetry in 1984-85. The negative trend indicates that the rates of increase declines with increasing colony size (r = 0.88, n = 10, p<0.001).***



At the beginning of the twentieth century, when Gurney (1913) made his first pioneering census, there were only 5 gannetries in Scotland: Ailsa Craig, St Kilda, Sula Sgeir, Sule Stack and the Bass Rock. The Scottish population was thought to be about 41,300 AOS. As we approach the end of the century, numbers have increased fourfold and there are 12 active colonies. All the evidence suggests that conditions are still extremely favourable for Gannets. However, the species is potentially of conservation concern because of its highly localised breeding distribution with 76% of the Scottish population and almost 50% of the east Atlantic population concentrated in just 3 colonies: St Kilda, the Bass Rock and Ailsa Craig.

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Gizzard contents of Pochard, Tufted Duck and Goldeneye from Loch Leven, Kinross, in winter 1994-95

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We examined the gizzard contents of 3 species of diving duck which fed on the benthos of Loch Leven during winter 1994-95. Tufted Ducks and Goldeneye appeared to be mainly carnivorous and Pochard mainly herbivorous. Chironomid larvae appear to be the most important food item overall. The results are discussed in relation to previous studies.

Introduction

Loch Leven National Nature Reserve is internationally important for its wintering wildfowl populations (Owen *et al* 1986) and 3 diving duck species occur there in nationally important numbers - Pochard *Aythya ferina,* Tufted Duck *A fuligula* and Goldeneye *Bucephala clangula* (Waters & Cranswick 1993). The diet of Tufted Duck and Goldeneye is thought to be primarily Chironomid larvae and other invertebrates. Pochard are thought to be mainly herbivorous (Cramp & Simmons 1977) although some studies have shown a predominance of Chironomid larvae in their diet (Winfield & Winfield 1994). The only previous study of diving duck diet at Loch Leven suggested that both Tufted Ducks and Goldeneye fed mainly on Chironomids (Laughlin 1973).

Eutrophication and associated algal blooms have become an important factor in determining aquatic plant growth in Loch Leven. The fluctuating water chemistry has also affected benthic invertebrates (eg Chironomids). Macrophyte and benthic invertebrate communities have been the subject of recent monitoring work on the loch (Murphy & Mulligan 1993, Gunn & Kirika 1994) though their importance to the diving duck populations has not been evaluated since work for the International Biological Programme (IBP) in the 1960s and 1970s.

Methods

Samples from birds' proventriculus and gizzards were collected during winter 1994/95 from freshly shot birds at Loch Leven. After labelling, each was frozen and stored before subsequent analysis. However, many samples refer to gizzard contents only. Consequently, because softer food, such as invertebrates, is often fully digested higher in the gut, analyses of gizzard contents bias estimates towards plant matter and seeds (Swanson & Bartonek 1970). As the resulting small samples are inappropriate for statistical analysis, age and sex classes of the birds have been amalgamated.

Identification and nomenclature for vascular plants follows Clapham, Tutin & Moore (1987), Chironomidae that of Bryce & Hobart (1972) and Bird (undated), Mollusca Macan & Cooper (1977) and other invertebrates Fitter & Manuel (1986).

Two estimates of gizzard contents are presented:

1 The proportion of birds with >5% of each food item in the gizzard (% occurrence).
2 The aggregate percentage dry weight (Swanson *et al* 1974). This is calculated by averaging the proportion of each food item per gizzard in the number of gizzards sampled. This gives equal weight in the analysis to each bird, and thus reduces bias, which may be introduced by individual birds feeding on large amounts of one food item or by variable amounts of total gizzard contents.

Results

Unidentified plant material was found in c80% of Tufted Duck and Goldeneye gizzards, and in all Pochard gizzards (Fig 1). However, Pochard gizzards contained nearly twice the amount of plant matter and a higher proportion of seed than the other 2 duck species (Fig 1, Table 1). *Polygonum, Potamogeton* and *Carex* were the dominant seeds found. Tufted Duck and Goldeneye gizzards contained mainly animal matter, mostly Chironomids and unidentified arthropods. Pochard gizzards also contained notable amounts of Chironomids, but Bryozoans were present in much higher quantities than in the other 2 species. Small amounts of leeches were present in all 3 species. Tufted Duck and Goldeneye had both fed on *Trichoptera* larvae while fish were only taken by Goldeneye.

Discussion

Gizzard contents

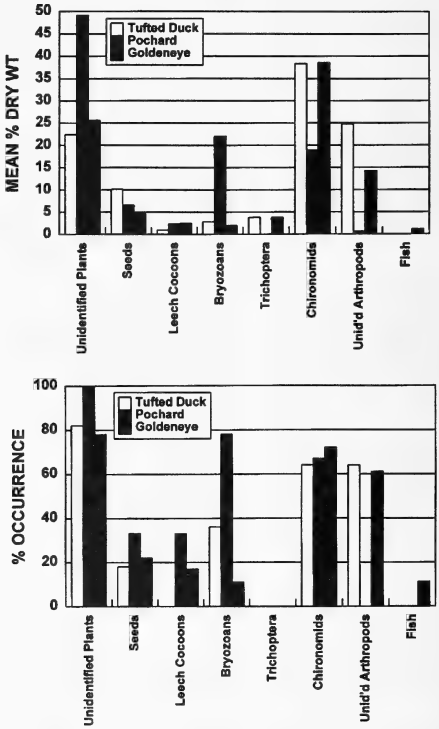
Gizzard analysis of birds shot apparently at random cannot be used to provide a quantitative estimate of diet, due mainly to the time lag between the intake of food and subsequent analysis of contents. This includes pre-mortem factors, such as the time delay between the cessation of feeding activity and shooting, and post-mortem factors, such as the differential digestion of soft versus harder food items. In addition, it does not necessarily follow that birds shot at a site have been feeding there.

A study by Winfield & Winfield (1994) on Lough Neagh showed that only 20% of shot birds had food in the oesophagus or proventriculus, whereas 85% of birds sampled from accidental netting incidents had food there. Swanson & Bartonek (1970) showed that analysis of gizzard contents alone produced a bias toward plant material, with animals such as molluscs, insects and crustaceans almost totally digested after 20 minutes in the gizzard and with digestive juices continuing to digest food for long periods after death. Because gizzard contents in this study were not obtained immediately following a bird's death, only a small amount of the gizzard contents could be identified accurately, especially in the case of Chironomids, which were mostly identified when partially digested or fragmented. Even determining family status proved difficult in many cases.

Pochard

Pochard feed by day and night, preferably at 1m-2.5m depth with dives lasting 13-30 secs. (Owen *et al* 1986, Willi 1970). Winfield & Winfield (1994), however, recorded birds feeding at up to 10m depth in Lough Neagh where Chironomids formed 90% of the diet. In the absence of benthic macrophytes, Pochard have also been found to feed selectively in areas rich in Chironomid larvae (Phillips 1991). These findings contradict other studies which describe the winter diet of Pochard as mainly

Figure 1 ***Gizzard contents of Tufted Duck, Pochard and Goldeneye at Loch Leven, winter 1994-1995.***



plants, chiefly the oospores of stoneworts, *Chara* and *Nitella*, and the seeds of submerged aquatic plants, especially *Potamogeton* (Owen *et al* 1986). Chironomids and other invertebrates are generally reported to comprise less than 15% of the diet (Olney 1968). However, the erroneous belief that Pochard are herbivorous presumably derived from earlier studies which analysed only gizzard samples.

Whilst also based on gizzard analyses, this study suggests that Pochard are omnivorous at Loch Leven, taking significant proportions

of both plant and animal material (mainly Chironomids and Bryozoans). A previous study at Loch Leven analysed one 'stomach' and also found that Chironomid larvae were taken (Laughlin 1973). We do not know whether the high levels of Bryozoans (*Cristatella mucedo* statoblasts) identified in Pochard during our current study were taken on purpose or were consumed inadvertently from benthic vegetation. The relatively higher proportion of plant matter in Pochard gizzards in comparison with the other 2 duck species may suggest the latter possibility.

In areas where Pochard and other species feed primarily on Chironomids, they may compete with a number of fish species, such as Brown Trout *Salmo trutta*, Rainbow Trout *Onchorynchus mykiss* and Perch *Perca fluviatilis* which occur in Loch Leven and Eels *Anguilla anguilla* (Winfield & Winfield 1994) although the latter are thought to be scarce in the loch. Chironomids are eaten by all these species. Thorpe (1973) estimated that Brown Trout consumed no more than 6% of the Chironomid production between June and September. This level is unlikely to have increased because a recent estimate of the fish population (O'Grady *et al* 1993) indicated that the Brown Trout population has declined since Thorpe's study and the Perch population has subsequently decreased dramatically. Annual stocking of Rainbow Trout since 1993 has done little to redress the balance in terms of fish biomass and we assume that fish predation on Chironomids, leading to competition with birds for food, has decreased. The results of this survey indicate that, while Pochard ate fewer Chironomids and more vegetable matter than the other 2 species, Chironomids still formed a large part of their diet.

Tufted Duck

Witherby *et al* (1940), Cramp & Simmons (1977) and Owen *et al* (1986) all describe this species as omnivorous, but emphasise a preference for animal matter, especially molluscs, which usually accounts for over 80% of the diet.

Between 300 and 600 pairs of Tufted Ducks are known to nest annually at Loch Leven (Lauder 1993) and Laughlin (1974) states that Chironomids formed 60% of the diet during this period. Other important items also taken then included caddis larvae and molluscs, especially *Valvata* spp. Thus it appears that Tufted Ducks at Loch Leven mainly eat Chironomid larvae. When looking at the energy flow through the loch, Laughlin found that water depth and depth of food in the substrate were 2 of the major factors affecting the availability of food for Tufted Ducks and that only 20% of the total loch area was suitable for feeding birds.

Laughlin (1974) also suggested that the autumnal peaks of Tufted Ducks at Loch Levren (typically c2,500 birds, but sometimes over 4,000 birds) were correlated with Chironomid production. The high numbers of Tufted Duck present in 1970, coinciding with peak biomass values for *Glyptotendipes* (Maitland & Hudspith 1974), provided evidence for this, but a wide range of other factors clearly affect Chironomid and waterfowl populations.

Goldeneye

Goldeneye are more solitary and usually feed at 3-10m but up to 55m (Cramp & Simmons 1977, Winfield & Winfield 1994) mostly in daylight but sometimes at night (Cramp & Simmons 1977). Goldeneye are known to

Table 1 ***Aggregate percentage dry weights of 9 Pochard, 11 Tufted Duck and 18 Goldeneye gizzards.***

Plant material	Tufted Duck n=11	Pochard n=9	Goldeneye n=18
ALGAE			
Chlorophyta (filamentous)	0.36		0.33
BRYOPHYTA			
Unidentified plant material	22.45	49.11	25.61
ANGIOSPERMOPHYTA			
Dicotyledones			
Unidentified (seed)	4.55	1.67	0.33
Ranunculaceae (seed)		0.33	
Leguminaceae			
Trifolium sp (seed)			0.06
Rosaceae			
Rubus fruiticosus (seed)			
Polygonaceae			
Polygonum sp (seed)	0.55	2.44	1.39
Rumex sp (seed)		0.44	0.11
Betulaceae			
Betula sp (seed)	0.09		
Compositae			
Cirsium sp (seed)	0.09	0.33	
Monocotyledones			
Potamogetonaceae			
Potamogeton sp (seed)	4.27	1.00	1.67
Cyperaceae			
Carex sp (seed)			1.00
Juncaceae			
Juncus sp (seed)	0.09	0.11	
Gramineae (seed)	0.55	0.22	0.11
Anther unidentified		0.22	
TOTAL PLANT MATERIAL	32.64	55.87	30.28
ANIMAL MATERIAL			
PORIFERA			
Spongillidae		0.22	0.56
PLATYHELMINTHES			
Cestoda			0.06
NEMATODA			0.06

ACANTHOCEPHALA	0.18		
ANNELIDA			
Hirudinea			
Erpobdella octoculata	0.91	2.33	2.44
BRYOZOA			
Phylactolaemata (statoblasts)			
Cristatella mucedo	2.82	22.00	1.89
ARTHROPODA			
Arachnida			
Hydracarina			
Arrhenurus caudatus & soft bodied spp	0.36	0.33	0.11
Crustacea			
Ostracoda	0.09		0.06
Isopoda			
Asellus aquaticus			0.28
Insecta			
Odonata			
Anisoptera larvae			0.06
Trichoptera			
Rhyacophilidae larvae	3.78		3.78
Phthiraptera	0.01		
Diptera			
Chironomidae			
Tanypodinae larvae	6.89	1.11	3.22
Chironominae larvae	5.82	15.33	8.61
Chironomid mucus tubes	25.55	2.22	26.61
Unidentified larvae			0.06
Unidentified imago		0.22	
Hymenoptera			
Evaniidae	0.09		
Braconidae		0.11	
Unidentified chitinous fragments	23.73	0.56	14.17
Unidentified ova	1.00	0.11	0.11
MOLLUSCA			
Gastropoda			
Unidentified opercula	0.18		0.06
Valvata sp		0.11	0.72
Planorbis sp	0.09		
Bivalvia			
Pisidium sp	0.09		0.06
VERTEBRATA			
Osteichthyes			
Gasterosteiformes			
Gasterosteus aculeatus	1.11		

feed actively at night at Loch Leven in illuminated water near Kinross. When feeding in flocks, birds may synchronise dives, or dive in succession with dives lasting 30-40 secs.

Our results suggest that Tufted Ducks and Goldeneye at Loch Leven were mainly carnivorous but Pochard were omnivorous. Laughlin (173) obtained similar results for the former 2 species at Loch Leven, but only analysed one Pochard 'stomach'. The range of items consumed appears to be similar for all 3 species with Chironomid larvae appearing as a major resource for each.

The high percentages of plant material recorded in Tufted Ducks and Goldeneye are likely to be a result of the differential periods of digestion outlined by Swanson & Bartonek (1974) and it is possible that most of this material had been ingested incidentally or is residual. This suggestion is supported by previous analyses of diets of Tufted Duck and Goldeneye (Eriksson 1979, Laughlin 1973, Olney & Mills 1963 and Cramp & Simmons 1977), all of which reveal little evidence of plant material as a major dietary component.

Chironomid productivity and diving duck numbers

Laughlin (1974) suggested that winter Chironomid production was a limiting factor for the number of Tufted Duck occurring on the loch. In May 1994, Gunn & Kirika (1994) found similarly high densities of Chironomid larvae. Tanypodinae (*Procladius* spp) were found mainly in muddy substrates, with a mean density of 4,106 m^{-2}, whereas Chironominae were found mainly in sandy substates at the following densities: *Cladotanytarsus* spp 11,086 m^{-2} and *Stictochironomus* spp.2,818 m^{-2}. One genus of Chironominae, *Tanytarsus* spp, was also found in reasonably high densities in mud (1,219 m^{-2}). However, the dominance of the Chironomus group in the gizzards and the frequenty of the cocoons of *Erpobdella octoculata*, a leech typically found on stony or sandy substrates, does suggest that most feeding occurred over sand substrates.

There have been changes in the relative abundance of the constituent genera of the Chironomid community in Loch Leven since the IBP programme in the 1960/70s and producitvity has been variable in what appears to be an unstable system as a result of nutrient enrichment (Gunn & Kirika 1994). Chironomid larvae appear to be the major food resource of diving ducks at Loch Leven and the population levels of benthic feeding waterfowl may well be determined by the productivity of Chironomidae in the loch.

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Waterfowl counts on the Tay Estuary, 1985-1995

N ELKINS & B M LYNCH

The Tay Estuary is an important site for both migrating and wintering waterfowl. It holds internationally important populations of wintering Eider, Redshank, and Bar-tailed Godwit. The wintering populations of Sanderling and Goldeneye achieve national importance. The estuary is a staging post for migrant waders in spring and autumn, and recent counts of migrant Sanderling, Knot, Ringed Plover and Turnstone have exceeded wintering populations, especially in spring. Mallard, Wigeon and Tufted Duck are all common wildfowl in winter, while Shelduck reach a spring peak. A substantial moulting flock of Goosander is present in late summer. This paper describes the numbers, distribution and changes in waterfowl populations on the estuary between 1985 and 1995, as shown by monthly high tide roost counts and a series of midwinter low tide counts.

Introduction

The Firth of Tay is the third largest tidal estuary in eastern Scotland, after the Moray Firth complex and the Firth of Forth. However, unlike the other firths, little detail has been published on its waterfowl populations. Any accounts available in local reports have concentrated on one area or another but not the whole, probably because the estuary represents the boundaries between Angus, Perthshire and Fife.

With the continuous monitoring carried out over the last decade or so, there is now a clearer picture of the importance of the estuary, and this paper sets out to describe its waterfowl populations, particularly the waders.

The study area

The estuary has an intertidal area of 5,720 ha with a tidal reach of 53km. Its contributing rivers, the Tay and Earn, provide the greatest inflow of fresh water of any British estuary (JNCC 1994).

The maximum width of the inner estuary is 5km, narrowing to 1.5km between Broughty Ferry and Tayport. The constriction is mainly due to the volcanic outliers of the Ochil Hills, which extend all the way along the southern edge of the estuary to cross into Angus at this point. The northern shore of the inner estuary is backed by a coastal plain some 8km wide with the Sidlaw Hills to the north.

The tidal range at Dundee is large, being 5.2m at the highest spring tides, and 1.7m at the minimum. At low tide, the inner estuary is characterised by extensive mudflats on the northern shore, fringed by large salt marshes, with the most extensive continuous stand of *Phragmites* reed swamp in Britain. The inner estuarine substrates consist of coarse sediments in mid estuary and fine mud sediments along the north shore, both of

which, because of their unstable nature and the large tidal range of salinities, support an impoverished variety of invertebrate fauna (JNCC 1994). However, these populations can be enormous and, from the distribution of feeding waders, we suspect that this fauna is more abundant at the eastern end. The outer estuary holds sandier intertidal flats both on the north and south shores, with considerable sublittoral populations of mussels *Mytilus edulis*, and several mussel beds exposed at low tide. On both shores adjacent to the estuary mouth there are extensive accreting sand dune systems. A natural division exists between the inner and outer estuaries where there is a 7km stretch of little or no intertidal flats. The adjacent shores here are mainly urban, where the rail and road bridges span the estuary. In all, the sand and mudflats cover 5,218 ha.

The main high tide wader roosts are situated at Tentsmuir Point and Lucky Scalp on the south shore, and the Monifieth/Barry Buddon shore and Kingoodie/Invergowrie Bays on the north shore (Fig 1). Tentsmuir Point is a sandy promontory where roosting birds use the shoreline. Lucky Scalp is a narrow high tide islet consisting of a sand/pebble stretch covered in rough grassland and marram *Ammophila arenaria*, and surrounded by a pebble shore which is all but covered by the highest tides. It measures 30m in length, and between 5m and 15m in width, and lies 600m from the coastal high water mark. The main roost at Monifieth is usually on the sand spit at the mouth of the Buddon Burn, but occasionally it stretches along the sandy shore towards Buddon Ness. Due to a very busy military live firing range on the Buddon Ness promontory, eastern most roosts have, at times, proved difficult to count with only estimates obtained. There is also a satellite roost near the mouth of the Dighty Water at Barnhill. The only inner estuary roosts are situated at Kingoodie and Invergowrie Bay. Here, a proportion of waders roost at Dundee airport. Subsidiary roosts can also be found on fields, including playing fields, around Tayport and Dundee, where some species feed during high tide.

Methods

As part of the British Trust for Ornithology's (BTO) Wetlands Bird Survey (WeBS) (prior to autumn 1993 this was called the Birds of Estuaries Enquiry (BoEE), monthly counts of roosting waders were carried out every winter. Counts during the remainder of the year were made from 1992. During winter 1993-94, additional regular monthly counts were also made of both roosting and feeding waders at low tide for the BTO's Low Tide counts scheme. This study uses all counts made for WeBS between September 1985 and August 1995.

In addition to waders, wildfowl were also counted on a less regular and comprehensive basis, together with some other estuarine species.

High tide roost counts were made on a specified date each month between September and March inclusive, usually at spring tides near the middle of the month, although during short winter days when high tide occurred during the hours of darkness, alternative dates were chosen. The median date for all complete coordinated counts was the 14th. On some occasions, severe weather or lack of observer(s) disrupted the regularity and simultaneity of counts. From 1992, similar counts were also made from April to August. Monthly low tide counts were made between November 1993 and February 1994 on a chosen date. In February 1994, the date of

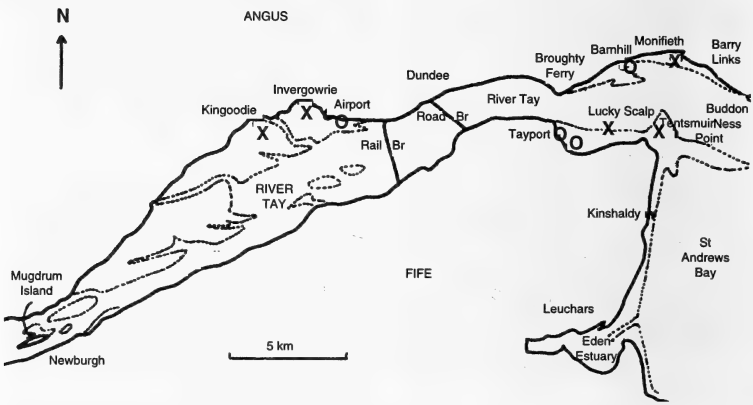

Figure 1 ***Map of the Firth of Tay showing mean low water mark (dotted) Main roosts X Subsidiary roosts O.***

the low tide count fell on the same day as the high tide count, so that a unique direct comparison was available.

With only 4 main high tide roosts, the logistics of providing simultaneous cover were simple. The low tide counts required more organisation; the estuary was divided into a total of 41 sections, with approximately 20 observers involved on each date.

The monthly figures (Table 1) are the 10 year means of all available counts for each roost site. For comparison, casual counts between 1970 and 1985 (for which tidal state was invariably not specified) were extracted from national and local Bird Reports, while BoEE counts were also scrutinised. For the latter, counts of the whole estuary, let alone coordinated counts, were rarely achieved during this earlier period. For this reason, long term trends in population sizes were not possible to detect for many species. Boase (1970) provided useful wildfowl data for the period prior to 1970. A few observations from the 1995-96 winter counts have also been included in cases where the data show new information.

The prevailing wind and weather conditions were noted on each count date. This information was supplemented by weather data from Leuchars, which was used to calculate mean values of temperature and wind speed, the atmospheric parameters assumed to be of most importance to shorebirds. These data were combined to produce a wind chill equivalent temperature for each winter. This is a partly subjective measurement calculated for suitably clothed humans! However, it is considered that the trend of these values may also be meaningful for a healthy bird insulated by plumage.

Results

Between winter 1985-86 and 1994-95, complete and fully coordinated roost counts were made in 48 (69%) of a possible maximum of 70 of the months between September and March inclusive. In the remainder, most counts were carried out within a few days of each other.

The average number of waders roosting on the Tay estuary in midwinter was 10,842. This figure was derived from summing the highest monthly counts of each species between November and February. This wintering population varied from 12,789 in the winter of 1985-6 to 6,797 in 1994-95. The variation between the same months in different years was also marked. For instance, the highest count was made in September 1989, when migrants swelled the population to 13,186, but a year later only 3,960 birds figured in the September count. In winter, Dunlin comprised 30% of the mean total and Oystercatcher 20%, while Bar-tailed Godwit and Redshank accounted for 14% and 13% respectively. Fewest waders were present in May, with a mean of 619.

The 2 winters of greatest wind chill were 1985-86 and 1993-94, coincident with high mean wind speeds and low mean temperatures. It is perhaps indicative of the relatively equable climate during the study period that no significant local effects on wintering populations were noted, although individual counts were affected during easterly gales accompanied by precipitation. Winters outside the study period, namely 1981-82 and 1995-96, have been severe enough at times to allow extensive ice to build up on the mudflats in the inner estuary. What effect this had on wader populations is unclear, although low wader numbers in the latter winter were second only to those of 1994-95.

Species accounts

Oystercatcher *Haematopus ostralegus*

Table 1 shows the rapid increase in the Tay estuary population in July, a steady over wintering population of around 1,700 with a peak in February, and a substantial exodus in March.

Of the total winter roosting population, 30-40% roost in the inner estuary between Dundee airport and Kingoodie. The remainder is found in the 3 outer estuary roosts, with apparent movement between the roosts dependent on tide conditions. The size of the roost on Lucky Scalp is highly correlated with the tidal height, with displaced birds moving to one or other of the outer estuary roosts. At high tide, small numbers sometimes feed on agricultural and sports fields surrounding Tayport, and these are included in the counts.

In the low tide and high tide coordinated counts on 13 February 1994, the roosting population was 20% less than that feeding earlier in the day. This may have been due either to the birds moving out of the estuary completely, or to their movement into uncounted areas such as Buddon Ness. The largest feeding concentration was off Barnhill. Although low tide counts in the other winter months were separated from high tide counts by a week, similar reductions were recorded. Most of these decreases seemed to be confined to the outer estuary.

The low tide counts in winter 1993-94 showed that the majority of birds chose to feed near the low tide mark in the outer estuary, utilising the mussel beds, and that the mean density of such birds was the highest of any of the wader species (Cranswick *et al* 1995). Numbers using the mussel beds varied from 17% to 58% of the total population. Those birds not

Table 1 ***Monthly means of wader roosting populations on the Tay estuary, September 1985 to August 1995.***

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	%	Peak
Oystercatcher	1758	1788	741	319	296	487	1282	1292	1422	1552	1738	1673	33	2153
Ringed Plover	82	84	29	21	24	3	75	102	175	108	98	86	0	125
Golden Plover	131	93	16	0	0	0	0	13	92	56	217	97	43	281
Grey Plover	172	182	169	197	27	6	14	160	200	143	148	161	0	263
Lapwing	379	202	56	24	21	61	91	589	828	270	559	363	88	684
Knot	176	161	113	8	0	0	0	51	128	64	92	138	0	394
Sanderling	170	183	131	80	9	0	1	63	92	124	188	240	0	335
Dunlin	3115	2409	665	147	121	3	20	128	811	1638	1834	1998	71	3230
Bar-tailed Godwit	1032	1074	393	95	32	29	393	474	867	991	809	971	5	1482
Curlew	248	329	320	186	22	69	208	185	375	155	196	191	47	441
Redshank	824	780	929	789	13	51	379	699	1529	1352	1224	810	74	1368
Turnstone	47	44	33	72	1	0	1	18	30	31	38	49	0	76
n	10	10	10	4	4	4	4	4	10	10	10	10		

% = % roosting on inner estuary, September to March
Peak = Mean maximum count, November to February
n = number of years counted.

recorded on mussel beds tended also to favour the lower shore, especially in the inner estuary. As at high tide, small numbers also chose to feed in adjacent fields.

As with all other waders, Oystercatchers do not feed in any great numbers on the extensive mudflats upriver from Kingoodie, where there is a scarcity of food. From mid February, small numbers can be seen upriver towards Newburgh, as they begin to move towards inland breeding sites.

Between May and August, the Oystercatcher is the commonest species on the estuary, comprising up to 60% of all waders in May and June. The midsummer flocks probably consist of immature birds and non breeding adults, while post breeding birds arrive from July onwards (Cramp & Simmons 1983). In late summer, when the population is swollen by migrants, a higher proportion roosts in the inner estuary, possibly because of disturbance by holiday makers along the sandy beaches of the outer estuary (Fig 2).

The peak count during the period occurred on 8 September 1991, when 3,124 birds were present. September is the month in which the species peaks over the whole of Britain (Prater 1981). Of this Tay count, only 19% roosted in the inner estuary, and 64% were present at Tentsmuir Point. Compared to winter months, this appeared to be an abnormal distribution, doubtless caused by the presence of a large number of passage migrants. Such abnormal distributions also occur in winter from time to time, possible due to disturbance, especially when birds roosting on or near the airport are subject to clearance.

There was no evidence of a significant change in the wintering population, although a comparison with figures for the inner estuary (Laing & Taylor 1993) suggests a decrease for this area. Average maximum counts for both autumn passage and winter rose steadily here between the early 1970s and the late 1980s, but the early 1990s showed a downturn of 10-20%. This apparent decrease is supported by the fact that, elsewhere on the estuary, some previous counts far exceeded present numbers. Peak high tide counts prior to 1985 have exceeded 3,000 in all months from August to December, while other counts, at unspecified tidal states (but probably at high tide), have been as high as 7,500 at Tentsmuir Point on 14 October 1973.

The Oystercatcher feeds readily inland, and studies have shown that snow and frost force inland feeders to unfrozen intertidal zones, while flooding due to high rainfall increases the amount of food available in inland fields. The high numbers counted in January and February 1991, and in February 1986, came in months of frequent frosts, while low numbers of roosting birds were counted in the exceptionally wet January of 1993. The low counts in November 1992 and 1993 followed very cold Octobers, suggesting that autumn immigrants may not have stopped but carried on southwards, although numbers recovered later in both winters.

Ringing indicates that most of the wintering Oystercatchers are from the large Norwegian breeding population (Cramp & Simmons 1983, Prater 1981), with some Scottish breeders. Local August ringed birds (probably migrants) have also been recovered in late spring in the Faroes, and in December in France. One bird ringed in February 1988 in Northern Ireland was recovered on the nearby Eden estuary in December 1991. Both winters were exceptionally mild in the Tay area, indicating that the apparent change in wintering site was not as a result of severe weather.

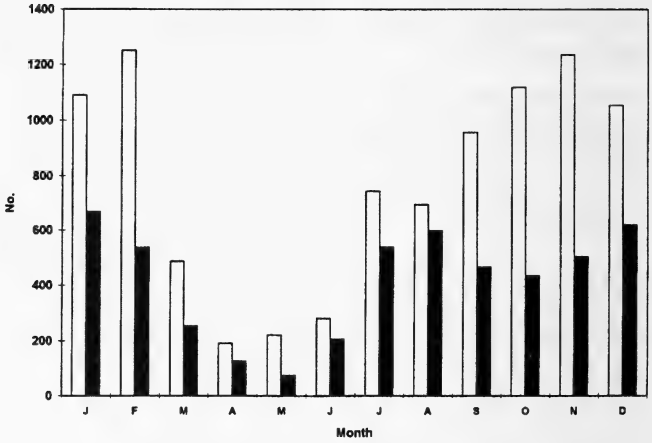

Figure 2 ***Mean monthly high tide roosts counts of Oystercatchers on the Tay estuary 1985-1995 Outer estuary □ Inner estuary ■.***

Ringed Plover *Charadrius hiaticula*

This species is chiefly a passage visitor to the Tay estuary (Table 1). During midwinter, a mean of 80-90 is present, with about 90% roosting in the outer estuary, mostly on the north shore. There is a sudden decrease in March. The maximum midwinter count was 197 on 14 January 1990.

During the 1993-94 low tide counts, the majority of the small population fed in the outer estuary, although small numbers were recorded on the upper shore of Invergowrie Bay. As the numbers roosting invariably exceeded those feeding, it seems that some of the roosting population comes from outwith the estuary, probably from close by on the uncounted beaches of Buddon Ness. Indeed, marked monthly variations suggest such a movement. For example, only 7 were counted at high tide in January 1986, but the following month the roosting flock rose to 164. Both these months were characterised by high wind chill, perhaps making flocks more mobile in search of shelter.

Autumn passage begins in July, reaching a peak in September. The peak high tide count occurred on 11 September 1988, when 315 were present, all on the outer estuary. The small May peak represents those recorded during the regular mid monthly counts. It does not, therefore, include late migrants which

pass through in the last 10 days of May. The rapid movement of such birds means that numbers may temporarily be high and, indeed, flock size on the outer estuary has reached 700. The mean of 8 counts between 1971 and 1989 in the last fortnight of May was 317, with most flocks resting at Tentsmuir Point.

A few pairs of Ringed Plovers breed among the dunes at the outer edge of the estuary.

Ringed Plovers are not abundant in Britain in winter. The population consists primarily of local breeders (Prater 1981) which represent the most northerly wintering population of the species (Cramp & Simmons 1983), and which leave their wintering grounds early. Migrants come chiefly from Iceland and Greenland. Those passing through in May are probably from the latter, since these are the latest to nest. Ringing returns show that migrants passing through east Fife may take both western and eastern coast routes through Britain, although there is some degree of loop migration. An autumn ringed bird was recovered in Dumfries in May, while an autumn bird from Kent passed through the Tay in May. One September ringed bird appeared in western France exactly 3 years later.

Golden Plover *Pluvialis apricaria*

The occurrence of Golden Plovers on the Tay Estuary is very variable. Flocks roost regularly on the intertidal mud at low tide and can be found feeding in adjacent pastures at high tide, although the majority leave the area altogether to feed inland. Studies of Golden Plover wintering behaviour in Scotland (Fuller & Lloyd 1981) have shown that about 60% roost in coastal habitats, mostly on intertidal flats; 70% feed on grassland but very few use this habitat for roosting.

Counts on the estuary, therefore, fluctuate markedly (Table 1), although the highest numbers are normally in November. Peak high tide numbers in this month in 1992 reached 560. No birds roost at Tentsmuir Point, the favoured high tide roosts being in fields at Tayport and in the inner estuary. At low tide, large flocks also roost both at Tayport, where up to 2,300 have been recorded on the intertidal mud in milder winters between October and February, and as far west as Newburgh. Few birds are seen during gales, when inland shelter is sought, and increases are noted when inland fields are frozen, although prolonged freezes usually result in mass emigration. However, there was no significant correlation of numbers on the Tay with weather variables.

Inferences about a species with such mobile behaviour in winter are difficult to draw from estuarine counts. Few are seen in October, when the bulk of the immigrant winter population arrives, but they are present elsewhere in the area in large numbers. It is probable that the wintering population consists of Scottish breeders and continental immigrants, the former departing early for their breeding grounds.

Grey Plover *Pluvialis squatarola*

Grey Plovers are both winter and passage visitors to the Tay. Table 1 shows that a roosting population of around 170 birds is present in winter, but this is subject to considerable variation. The highest count was of 482 in February 1987, in contrast to the 20 birds present at the same time during the following winter. Another peak, of 414, occurred in November 1993. Both these peaks coincided with anticyclonic weather, when mean wind speeds were among the lowest during the study period. This may be

significant for a species that finds it increasingly difficult to feed when winds exceed 11 m/s (Dugan *et al* 1981). Wind chill temperatures were not particularly low in these 2 months; thus the positive physical effects of the light winds were probably more important.

The high and low tide counts in winter 1993-94 showed that the small numbers roosting on the outer north shore equalled those feeding. However, those on the south shore fluctuated markedly, with high tide numbers exceeding those at low tide in November and February, but the reverse in December and January. This suggests that there is considerable movement between the estuary and favoured sites elsewhere in the local area. Counts at the nearby Eden estuary suggest that there is an interchange between the Tay and the Eden and, indeed, flocks have been recorded departing from Tentsmuir Point at high tide, heading south.

The autumn and spring migration periods show an increase in numbers, with arrivals in August and September, and a spring peak in April. A few linger into May, while the return begins in July.

All but a handful of birds roost and feed on the south shore, and the highest recorded count was 676 at Tentsmuir Point in September 1976. This site is the major high tide roost on the estuary, though casual counts reveal an occasional large migrant flock on the north shore.

It has been determined that the species has increased dramatically in Britain over the past few decades (Cranswick *et al* 1995), and this has been mirrored by increases on the Tay.

Lapwing *Vanellus vanellus*

Like the Golden Plover, the Lapwing is a bird of inland habitats in winter, although roosting flocks can be found on exposed intertidal flats where, compared to the plovers, more feed. Thus numbers on the Tay fluctuate considerably.

Peak numbers occur during the autumn migration (Table 1). The bulk of Lapwings (90%) roost on the inner estuary at both high and low tides. The highest count was of 2,000 in September 1987, although up to 4,000 have been recorded in the past on the extensive mudflats at low tide. Small numbers also roost at Newburgh at high tide, but few utilise the outer estuary, although small numbers roost at Tayport at low tide. Most can be found on adjacent grassland.

Continental migrants augment the local populations in winter (Prater 1981)and some effects of severe weather have been noted, similar to those described for Golden Plover.

Knot *Calidris canutus*

The Knot is one of the species which has fluctuated greatly on the Tay. During the study period, numbers peaked in January and February, with 1,200 in 1987 and 770 in 1986 being the highest counts respectively (Table 1). During the 1993-94 winter, the small numbers present fed at low tide on the outer estuary. 90% of the wintering population roosts at Tentsmuir Point.

Autumn migration begins in late July with an upsurge in August and September. During this period a few birds are found on the inner estuary. A sudden drop is apparent in April as migrants depart, and occasional birds occur in summer.

There is ample evidence that the number of Knot wintering on the Tay has decreased in the last 3 decades. Although in a national context it has never been an abundant species, prior to the early 1980s wintering flocks of 1,000-1,500 were not infrequent, but nowadays these numbers are unknown. It is known that Knot suffer from a reduction in food availability during periods of low temperature (Goss-Custard *et al* 1977), but the drop in numbers on the Tay does not appear to be related to the severity of the winters during the study period. In view of the far greater numbers wintering on the nearby Eden estuary, and also on the Montrose Basin, the Tay population can probably be counted as an offshoot of this. Tay Ringing Group data have shown considerable winter movement between sites on the Angus and Fife coasts.

Our birds come from North Greenland and Canada, with a midwinter peak due to birds crossing the North Sea from the Waddensea after moult, returning in late winter to fatten before spring departure (Prater 1981, Tay Ringing Group *in litt*).

Sanderling *Calidris alba*

The Tay Estuary and shores of east Fife hold one of the most important wintering Sanderling populations in mainland Scotland. The regular monthly counts (Table 1) reveal a wintering population on the Tay which reaches a peak in December, with a maximum count of 750 in 1985. The birds are found mainly on the north shore of the outer estuary, though greater numbers roost at Tentsmuir Point in late winter. The counts suggest that the wintering population has declined since a peak in the mid 1980s. In the early 1970s, 1.3% of the west European wintering population occurred on the Tay (Prater 1981). Up to 1991-92, flocks were of national importance in most winters. However, casual counts undertaken outwith the WeBS survey show that flocks of 400-600 still occur, suggesting considerable fluctuation. It may be that the uncounted shores around Buddon Ness and south to Kinshaldy provide the source of these birds, since small flocks are recorded there from time to time during winter. Certainly the species is susceptible to gales, as it feeds at the tide edge (Johnson 1985), and often moves to sandy non estuarine shores in severe weather (Moser & Summers 1987). Numbers of wintering Sanderling in the present study do show a small negative correlation with wind speed.

The low tide counts in 1993-94, when the roosting population was as low as 75, showed that the birds fed in the outer estuary, where they favoured sandier substrates. Very few have been recorded from the inner estuary.

As with Ringed Plover, the passage of Sanderling is not very evident from the regular monthly counts. However, substantial spring and autumn passage movements have been recorded, peaking at 450 in May, while numbers in August and September have reached 250 and 350 respectively. Parties of up to 44 have been seen in July.

A colour ringing study by one of the authors (BML) between 1986 and 1990, during which 158 individuals were marked, showed that our wintering birds probably originate from the NE Greenland population. There have been 25 sightings of Tay ringed birds in May from staging sites in SW Iceland, from where the birds have departed for Greenland by 25 May (Gudmundsson 1992). The ringing study also suggests that spring migrants may stage through the Waddensee as well as Iceland, and that, in autumn, some birds route via the Baltic Sea coasts. Some colour ringed birds have returned to the Tay as early as July, with

the wintering birds having left by late March.

Dunlin *Calidris alpina*

This species is the most numerous wintering wader on the Tay where the peak is reach in January (Table 1). The maximum high tide roost count was 4,657 in January 1994; 70% of the population roosts in the inner estuary. In midwinter, small flocks of up to 250 have been recorded feeding on fields at high tide as far west as Newburgh, suggesting that roost counts may not encompass the whole population. Between October and February, Dunlin comprise between 35% and 50% of the total wader population on the Tay.

The low tide counts in 1993-94 show that the bulk of Dunlin also use the inner estuary for feeding, mainly off Invergowrie and Kingoodie. On 13 February 1994, the number of birds counted there increased by 25% between low tide and high tide, while a large increase was also noted in the smaller flock on the south shore of the outer estuary, suggesting an influx of birds from outwith the counting area. Counts at the Eden Estuary do indeed suggest that there is an interchange between the 2 estuaries. It is known that the density of feeding birds is related to the amount of mud substrate present, thus accounting for the high percentage feeding in the inner estuary. There was no evidence of any weather related fluctuations during the study period.

Few Dunlin are recorded in summer, but the highest numbers are present during autumn migration. 5,292 was the highest count, in October 1988, but, in October 1973, a count topped 10,000 in the inner estuary. From ringing, it is evident that our birds are of the immigrant race *alpina* from northern Scandinavia and Russia (Tay Ringing Group *in litt*). These normally arrive in late October via the moulting grounds on the Waddensea (Prater 1981). The sizeable roost at Tentsmuir Point in October and November may be related to this arrival. Some longer distance passage birds also stage through the area, as locally ringed birds in July and August have been recovered in Portugal and Senegal.

As with the other common wader species on the Tay, a marked reduction in the Dunlin wintering population was recorded in 1994-95, when the highest monthly count in winter was only 57% of the long term mean.

Bar-tailed Godwit *Limosa lapponica*

This species is one of 2 (the other being Redshank) which reaches numbers of international importance on the Tay, with maximum roost counts exceeding 1,500 in most winters. More than 1% of the west European wintering population roosts on the Tay (Prater 1981). The peak occurs in February (Table 1), with the highest count in 1992, when 2,296 birds were present. Most of the wintering and migrant populations roost on the outer estuary, divided between Monifieth and Tentsmuir Point, although the proportion at each site seems to vary according to wind strength and tidal height.

Low tide counts in 1993-94 showed that the inner estuary and the shore off Broughty Ferry are both important feeding areas, although the latter held the highest density of feeding birds (Cranswick *et al* 1995). All feeding birds leave the inner estuary as high tide approaches, as do most of the Broughty Ferry birds, flighting to the outer estuary to roost. The Bar-tailed Godwit is one of the more mobile species on the estuary. As the tide turns, the roosting flocks are among the first to return to feeding sites, typically landing on the flats to feed before the water has receded. At Tentsmuir Point, flocks have been noted arriving from the south before high tide.

If disturbed at roost, some return south. The probability that there is some interchange between the Eden and Tay estuaries is supported by the consistent shortfall of feeding birds compared to roosting birds in the 1993-94 winter.

Bar-tailed Godwits begin to arrive in July, with a minor peak in autumn. The main arrivals on the east coast estuaries occur from November when moulted birds flight in from the Waddensee (Prater 1981). Increases are also noted in Britain when severe winters occur in that area (Cranswick *et al* 1995). They return rapidly in March to fatten before departure for the breeding grounds. Birds ringed in November in east Fife have been recovered one month later in Portugal, indicating onward passage down the east Atlantic flyway, and in April in northern Russia, giving a clue to their origin.

No long term trends can be detected, although Boase (1970) recorded an increase after 1960 to up to 300 wintering in Invergowrie Bay. However, the winter of 1994-95 saw a marked reduction in the wintering population, with the highest monthly count being only 36% of the long term mean. Counts from the 1995-96 winter indicated a return to normal.

Curlew *Numenius arquata*

The Curlew is another species which is very catholic in its habitat requirements, being found on inland fields when unfrozen, as well as intertidal flats and rocky shores.

Winter roosts on the Tay can be substantial, with up to 500-600 having been counted in the inner estuary in midwinter (Table 1). During the low tide counts of 1993-94, small numbers were distributed throughout the inner and outer estuaries, but feeding predominantly at Invergowrie and Tayport.

The roosting population is at its maximum in late winter and early spring, building up in July with an autumn peak in September. This is similar to the pattern on other North Sea estuaries (Prater 1981), and suggests that the local population is augmented by migrants. The decrease in October is thought to be due to autumn flocks moving inland.

No long term trends could be detected in this species, although there was a slow decline over the study period.

Redshank *Tringa totanus*

Like the Bar-tailed Godwit, numbers of Redshank also reach international importance on the Tay, but only in some winters.

The average midwinter roosting population is between 800 and 1,000, but occasionally exceeds 1,500. Over 70% roost in the inner estuary, with the remainder divided among the outer estuary roosts. Low tide counts in 1993-94 revealed that the vast majority feed near their roosts off Kingoodie and Invergowrie, although the highest density of feeding birds occurred near low water mark off Monifieth (Cranswick *et al* 1995). On 13 February 1994, the inner estuary flock increased by nearly 50% between low tide and high tide. Small parties also feed on adjacent pastures at high tide but, unlike Curlew, Lapwing and Golden Plover, this represents only a tiny proportion of the total wintering population.

Peak numbers occur during the autumn migration, when over 1,500 are present (Table 1). The highest count was in September 1989, when 4,713 birds were counted, although casual counts have peaked at 6,900 in October, and rarely 2,500 in April. The Redshank is the most abundant wader species

(around 40% of the total) on the Tay during the migration months of March, April and September. Only small numbers are present from May, with arrivals from July, when British breeders move to the coasts.

Icelandic birds have been caught locally in October, while birds ringed locally have been recovered in Iceland in summer, indicating the origin of most wintering birds (Tay Ringing Group *in litt*). A September ringed bird from the Eden estuary was also recovered in Nigeria in January, showing that staging of Scandinavian migrants, which have the longest migration, occurs.

Boase (1970) recorded similar numbers on the inner estuary at migration periods, but no long term trends were detected. The marked reduction in 1994-95 in the wintering population of the more abundant species was also reflected in Redshank numbers, with the highest winter monthly count being only 40% of the long term mean (Fig 3).

Turnstone *Arenaria interpres*

Although primarily a non estuarine species, which has a substantial wintering population on the open Angus and Fife coasts, small numbers do frequent the Tay estuary. The

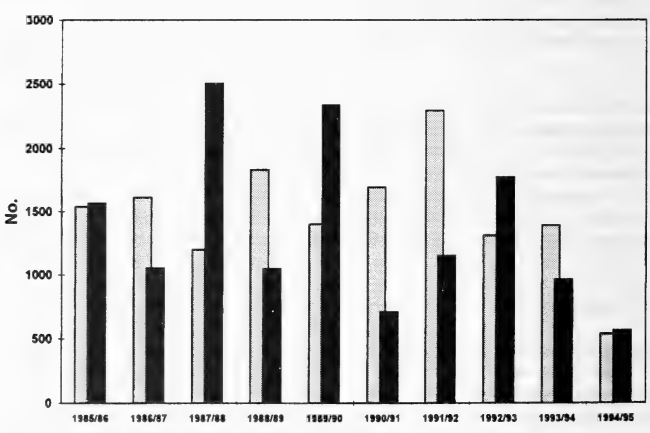

Figure 3 ***Peak winter counts of Bar-tailed Godwit and Redshank roosting on the Tay estuary, 1985-1995, Bar-tailed Godwit □ Redshank ■.***

wintering population is small, with up to 50 birds (Table 1). The majority are found where mussel beds provide feeding, notably off Monifieth and, to a lesser extent, off Tayport. The highest count was 142 in December 1991.

However, the highest mean (72) occurs in April, and, like Ringed Plover and Sanderling, there may be a considerable turnover of migrants at that time, with peaks occurring outwith the regular monthly counts.

The Turnstone population wintering in the UK originates in Greenland and the Canadian Arctic, while autumn migrants include Scandinavian breeders (Prater 1981). One bird ringed in September 1985 on the Angus coast was recovered on Ellesmere Island in the following June.

Other wader species

Small numbers of other species are recorded on the estuary, mainly during migration. Of these, the only regular wintering species is the Snipe *Gallinago gallinago*, which occupies salt marshes in the inner estuary, and the smaller salt marsh by Tayport. Due to its secretive behaviour, total numbers are unknown. Maximum numbers occur in October, November and January, with a peak count of 30.

Wildfowl

Wildfowl figured less comprehensively in the counts, but sufficient data were obtained to enable an assessment to be made of numbers and distribution of several species.

Mute Swan *Cygnus olor*

Mute Swans frequent the estuary throughout the year and a few pairs breed. Marking with unique Darvic rings has proved that the Tay Mute Swans, in common with others in eastern Scotland, make considerable movements up and down the east coast during the year, although many individuals are fairly sedentary (L Brown pers comm).

A herd of up to 65 is present in the outer Tay between September and February, chiefly at Tayport in autumn but in the Monifieth/ Broughty Ferry area from January. A herd of up to 80 also winters upriver near Mugdrum Island or at the mouth of the River Earn, but these do not figure in the WeBS counts. Birds disperse to breeding sites in early spring, but a flock of non breeders then congregates near Broughty Ferry, to be joined by failed breeders to form a pre moult herd of 30-60 birds between April and July. In 1991, this herd apparently moved up to Mugdrum in June. Such early summer flocks are also noted on the Eden estuary and at Musselburgh on the Forth; all such flocks diminish considerably in August as birds move elsewhere to moult. From May to July in 1995, over 100 were present on the north shore of the outer Tay, mostly at Monifieth. Many of these birds may have originated from the River Earn herd, which departs at the end of April.

In winter and on migration, the Mute Swan herds are occasionally joined by a few Whooper Swans *Cygnus cygnus*.

Shelduck *Tadorna tadorna*

This species can be seen in all months, although spring is the period during which it is most common. A few pairs breed. On average of fewer than 10 birds over winter, feeding mainly in the inner estuary, with a rapid build up occurring from February. The peak is reached in April, with over 100 birds present at times between March and June, the

maximum being 186 in March 1991. This influx probably consists of birds en route from wintering grounds to breeding areas.

In most months, the species frequents the south shore near Tayport, where small parties roost on Lucky Scalp, and the inner estuary, where the majority of the spring influx is found. A few can be located as far west as Newburgh, and, in summer, a number of broods swell the ranks. These keep to the hidden areas of the inner estuary, and may not be monitored on the WeBS counts. A rapid decrease then occurs as the birds depart for their moulting grounds. Boase (1970) recorded numbers in the 1960s of up to 300 off Kingoodie in spring, so there appears to have been a decrease on the Tay since then.

Wigeon *Anas penelope*

This is essentially a winter visitor to the estuary, arriving in September and departing in March. The peak is reached in November, with a mean of 155, but over 200 are frequently recorded between October and January. This represents a recovery in numbers since an earlier decline in mid century (Atkinson-Willes 1963). The maximum occurred in November 1994, when 262 were present. The majority feed and roost around Lucky Scalp, but small numbers also feed at low tide on the foreshore between Monifieth and Broughty Ferry. Casual counts also reveal a significant feeding flock west towards Newburgh (526 in November 1995). No Wigeon are seen between May and August. Boase (1970) recorded the species as being only 'casual' off Kingoodie.

Teal *Anas crecca*

The Teal is a highly mobile species in winter, dependent upon unfrozen inland waters. Nevertheless, it has shown a marked decline during the period. Prior to 1990, numbers wintering on the Tay regularly exceeded 50 birds, with over 100 recorded in January and February, while higher counts have been made in the past (Atkinson-Willes 1963). The peak count was 190 in January 1986. Since 1990, none has been seen in some months, and parties have not exceeded 45 in number. However, although at high tide they are mainly to be found around Lucky Scalp, the reedbeds of the inner estuary may also be frequented and thus they are difficult to locate. Substantial low tide feeding flocks eg 130 in November 1995, have been recorded towards Newburgh, on a par with counts given at that site by Boase (1970) in the 1960s. Any decline may be linked to the greater frequency of mild winters, when birds are able to remain inland.

Mallard *Anas platyrhynchos*

Mallard are the commonest freshwater ducks on the Tay estuary, peaking in January with a mean of 626, but with a minor peak in September, probably due to migrants. Historically, the species was very abundant (Atkinson-Willes 1963, Boase 1970), but numbers have fallen since then, with the maximum count being 1,419 in September 1986, although 1,150 were present in midwinter 1991-92 and 1992-93, and other counts have exceeded 2,000. There is a marked exodus in March and April, with an early upsurge in August. Flocks frequent Lucky Scalp at high tide, but feeding birds keep mainly to the foreshores off Invergowrie and Broughty Ferry and upriver.

Tufted Duck *Aythya fuligula*

This is a species which is found almost entirely in the inner estuary, where counts have been sporadic. Nevertheless, enough data are available to show that the peak is in January, when as many as 720 have been present (1987), and the mean is over 300. Few have

been recorded between March and August. This inner estuary flock was also present in the 1960s (Boase 1970) but at the same time there used also to be hundreds off Dundee and Monifieth in winter, where now there are few.

Eider *Somateria mollissima*

With peak numbers over 20,000 between autumn and spring, the Tay Eiders are of international importance. However, regular counts are not undertaken, as many feeding rafts are often out of sight beyond Tentsmuir Point, and tide dependent feeding movements present great difficulties to counters (Pounder 1971, Cranswick *et al* 1995). Several hundred roost on Lucky Scalp at high tide. Winter 1995-96 saw a concerted effort by local counters and staff of the Wildfowl and Wetlands Trust to determine numbers. Accurate counts are only possible under ideal conditions. This was highlighted in November 1995, when a count on the flood tide in bright sunshine and a moderate westerly wind revealed around 11,500 birds. Only 3 hours later, at high tide with the sun obscured, a freshening wind, and a redistribution of many birds into the choppier waters of mid channel, only 6,500 were located.

Goldeneye *Bucephala clangula*

This species winters in nationally important numbers throughout the estuary, but mainly west of the Tay bridges. Apart from a few early individuals, birds arrive in October and November, building to a peak in January, although a secondary peak in March suggests passage. The highest counts were of 344 in January 1992, and 351 in March 1987. Irregular counts at Newburgh have revealed flocks of up to 200, so that the monthly counts lower down the estuary monitor only part of the population. Small numbers are still present in April, but the majority have left by the end of the month. Boase (1970) recorded several hundreds wintering in the early 1960s, off Invergowrie and also Dundee and Monifieth.

Goosander *Mergus merganser*

There is evidence that the large moulting flock found in late summer is a relatively recent occurrence. Previous to this study, small parties were noted both in spring and in late summer (Boase 1970), but there is also the possibility that there may have been confusion between Goosanders and Red-breasted Mergansers *Mergus serrator*, as all the former are redheads while moulting. The flock begins to build up in June, reaching nationally important numbers in July and August. The peak count was of 277 in August 1995. Most of the birds depart rapidly in mid September, although there were still 225 in the third week of September 1987. Occasional small parties are recorded into November, with some frequenting the upper reaches near Newburgh in winter. At high tide, most roost on Lucky Scalp, but at low tide they disperse both up and down river in smaller parties. The origin and destination of these birds is at present unknown. It is thought that the large breeding population in northern England and the Borders may be the source, although a bird from the increasing Welsh population was recovered on the Eden estuary in August 1992.

Other wildfowl species not monitored regularly by this study include geese, mainly Pink-footed *Anser brachyrhynchus* and Greylag *Anser anser*, which roost in large numbers (exceeding 5,000 and 1,500 respectively) from time to time on the inner estuary, and also feed in adjacent fields. Sea duck, such as Long-tailed Duck *Clangula hyemalis* and Red-breasted Merganser, can be found in small numbers in the outer estuary but more

importantly on the sea to the south.

Discussion

An understanding of the changes in waterfowl populations on the Tay estuary cannot be achieved in isolation from other coasts and it has been noted that there is probably a large degree of movement of some species between the Tay and the Eden, and doubtless also between the Tay and Angus shores. There is also movement between the high tide roosts on the Tay. Laing & Taylor (1993) gave some trends for the inner estuary, but there is considerable evidence that for some species this cannot be meaningful in isolation from the outer estuary.

Changes in species numbers have been described under the species accounts. A number of factors are probably responsible for these fluctuations: breeding success, changing winter mortality and weather probably being the most important. Local climatic fluctuations have already been described. Further afield, NW Europe, where many species stage in autumn and early winter, experienced similar temperature anomalies in most early winters to those that affect the Tay. The exceptions were in 1988-89, when temperatures in November and December exceeded the long term mean to a much greater degree locally, and 1991-92, when the reverse was true.

Overall, the wintering wader population varied between 10,000 and 13,000 over the period. However, the winter of 1994-95 saw a dramatic drop in the number of birds using the estuary, when the number fell to 6,800 (60% of the 10 year average). The 4 most common wintering species were all affected, but Bar-tailed Godwit and Redshank both fell to 40% of their average (Fig 3). As the 4 species have rather different migration strategies, the reason for this decrease is unclear, although both breeding success and climatic conditions on the near continent may have played a part. Counts in the winter of 1995-96 showed that Bar-tailed Godwit numbers recovered, but populations of Dunlin and Redshank remained relatively low.

Any statutory protection afforded to the estuary such as the proposed Special Protection Area (SPA) must take into account the movements between sites within and without the estuary. At present the bulk of the estuary is covered by Sites of Special Scientific Interest (SSSIs), made up of the inner estuary (5,400 ha, including the subtidal area), Monifieth Bay (213 ha), Barry Links (1,041 ha, including the sand dune system) and most of the Tayport-Tentsmuir coast (1,044 ha). A part of the latter is also a National Nature Reserve.

Disturbance to waterfowl varies, but is generally at what seems to be an acceptable level. All roosts except Lucky Scalp are subject to disturbance by walkers, especially in fine weather. Roosting at Dundee airport can be interrupted by aircraft and bird control activities, often to the extent that the roost is completely displaced. Speedboats in the outer estuary disturb wildfowl on the water but the problem is small in winter. At low tide, there is a limited amount of bait digging, but this is thought to cause only minor damage. Any future increase, for instance large scale commercial exploitation, would create a far greater problem. Natural disturbance is confined to the highest tides, especially when onshore winds enhance tidal heights, and normal roosts are covered. Many birds then vacate the area and move to unknown destinations, although this is rare, with only 3 counts undertaken when these conditions prevailed. There was no apparent correlation between tidal height and the total roosting population. However, increased tidal heights

have been shown to be detrimental elsewhere at low tide by covering feeding sites (Pienkowski & Prokosch 1982).

Regular monitoring of water quality has been carried out by the Tay River Purification Board (now the Scottish Environment Protection Agency). The Tay Estuary generally has a good water quality, despite the discharge of sewerage products, mainly in the Dundee area; some untreated discharges give locally poorer quality water, but progress to improve these is in hand. Over the period of study, it is not known if changes have had any effect on the bird populations. Sewage outfalls in the Invergowrie/Kingoodie section may indeed be the reason for the large number of feeding waders along this stretch of mudflats, (Pounder 1976) and it remains to be seen whether cleaning up discharges will result in any redistribution of waterfowl.

The Tay Estuary is an important link in the chain of estuaries along the east coast of Scotland. If the wildfowl, including sea duck, are taken into account, the wintering waterfowl populations of the Tay, Eden and St Andrews Bay exceeds 50,000, of which half are waders, with 3 species reaching international importance, and another 13 (7 waders and 6 ducks) being of national importance. Other waders reach national importance by virtue of their migrant populations.

Acknowledgements

A great debt is due to all those who put in the effort to obtain the data and who continue to count. Apart from the authors, the bulk of the counting was carried out by Dave Bell, Dave Ferguson, the late Steve Fulford, Sylvia Laing, Wendy Mattingley and Donald Stewart.

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Roosting Ringed Plover *David Mitchell*

SHORT NOTES

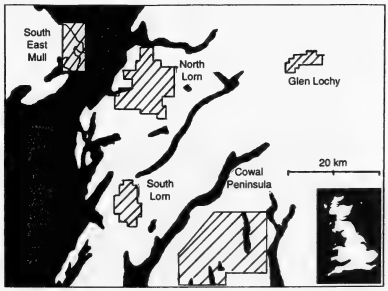
Nest site selection by Buzzards in mid Argyll

Buzzard nests are sometimes sizeable and conspicuous structures. The birds are known to use a wide variety of tree and crag sites (Picozzi & Weir 1974, *British Birds* 67:199-210; Fryer 1986, *British Birds* 79:18-28; Maguire 1979 *Western Naturalist* 8:3-13; Dare 1989, *The Naturalist* (Leeds) 114:3-31, Holdsworth 1971, *British Birds* 64:412-420). Ground nesting behaviour was recorded by Maguire in Kintyre, and occurs infrequently in Argyll (*pers obs*), but has not been recorded in any of the detailed Buzzard studies made in the south of England (Tubbs, 1974, *The Buzzard* David & Charles; Dare 1961, *Ecological observations on a breeding population of the Common Buzzard, Buteo buteo,* PhD thesis, Exeter University). The location of nests on the ground might be thought to make the nest particularly vulnerable to predators. As part of an investigation of Buzzard breeding distribution in Argyll, we considered whether there may be a shortage of suitable nest sites which led to ground nesting, and which might also limit the distribution of these birds. In this note we consider the selection of nest sites by Buzzards and their breeding success in different sites.

Field work was carried out in 3 main areas of Argyll (Figure 1): north Lorn (including Glens Lonan, Feochan and Euchar to the east and south east of Oban), south Lorn (to the north of Lochgilphead) and Glen Lochy (between Tyndrum and the Lochy and Orchy rivers). Attempts were made to locate every nest within these study areas in 1989 and 1990. Each nest was usually visited a number of times each season, to obtain information on clutch size, laying dates, brood size and fledging success. The laying date was usually estimated from direct observation of the date of hatching, or from measurements of the stage of growth of the chick from which its hatching date could be extrapolated. Nests were described as on crag sites where they were located on open rock faces. Bank sites were situated on vegetated ground, usually on steep banks alongside gullies, but with no exposed rock.

A total of 34 nests was located in 1989 and 39 in 1990. Many occupied nest sites had those from previous years in close proximity. 68%

Figure 1 ***Study areas. The areas for which complete coverage was obtained were: South east Mull 50 km^2, North Lorn 140 km^2, Glen Lochy 35 km^2, South Lorn 43 km^2, Nest sites on the Cowal Peninsula included in the analysis with the kind permission of Steve Petty and David Anderson.***



of nests were in trees and Table 1 shows that there was a clear preference for larger trees. Birch was undoubtedly the commonest tree species in North and South Lorn, yet was rarely used if larger trees were available. The crags used for nesting were from 5 to 50 m high, and the nesting ledge invariably had a vertical rock face immediately below the nest, although this was often only a few metes high. The nests were usually readily accessible on foot, although they were hidden by vegetation when viewed from below. There was no evidence that bank nesting was used because of a shortage of suitable trees. In all cases, bank nests were sited in woodland or wooded gullies, with apparently suitable tree sites in close proximity, often containing nests from previous years.

Table 1 ***Numbers of nest sites occurring in trees of different species used by tree nesting Buzzards in mid Argyll.***

Tree species	Number of nests
Oak *Quercus spp*	19
Spruce *Picea spp*	12
Birch *Betula spp*	4
Scots Pine *Pinus sylvestris*	4
Ash *Fraxinus spp*	3
Larch *Larix decidua*	2
Cypress *Chamaecyparis spp*	2
Douglas Fir *Pseudotsuga menziesii*	2
Rowan *Sorbus aucuparia*	1
Beech *Fagus sylvatica*	1

Table 2 shows the breeding performance of Buzzards from different nest sites. There was a significant difference in laying dates between the sites (Kruskall-Wallis one way ANOVA = 11.63, $P < 0.009$) and multiple comparison tests showed that clutches laid in bank nest sites were laid significantly earlier than those laid in the other nest sites. There was no significant difference in clutch size or brood size, but there was a significant difference in fledging success ($K = 8.94$, $P < 0.03$) and multiple comparison tests showed that significantly fewer young fledged from crag sites than from tree or ground sites.

There was no evidence that Buzzards nesting on the ground experienced a higher level of predation than birds using tree or crag sites. Crag sites actually had a higher proportion of nest failures, although the causes could not be determined. It is reasonable to assume that nests on the ground would be exposed to a greater range of predators than those in trees or crags. There is, presumably, some advantage to ground nesting which compensates for this. Buzzard nests are conspicuous, and the first birds to lay will do so before trees are in leaf. If egg predation by corvids and other avian predators is an important cause of breeding failure, it may be that ground nests are less conspicuous at the start of the season. In addition, ground sites may be more protected from wind and rain; this would be particularly important early in the season when leafless trees provide little shelter. This may be why females which are going to breed early in the season are more likely to choose a ground nest site. By doing so they can take advantage of an early start to the breeding season without incurring the higher energy costs that are probably associated with incubation in exposed sites in unfavourable weather conditions. This may explain why ground nesting has not been reported from areas such as the south of England, where the weather is less severe early in the breeding season, and where trees are in leaf earlier in the year.

We are very grateful to David Anderson, David Jardine, Mike Madders, Steve Petty,

Table 2 ***Breeding performance of Buzzards in mid Argyll in relation to nest site situation. Laying date is given with reference to 1April (day one). Brood quality rank is based on 1=brood consisting principally of nestlings of low weight for age, 2=brood consisting principally of nestlings all of expected weight for age and 3=brood consisting principally of nestlings of high weight for age.***

	Nest site situation			
Breeding parameter	Bank (n=14)	Coniferous trees (n=20)	Deciduous trees (n=30)	Crag (n=9)
Laying date (Median and range)	9 (5-37)	16 (5-30)	14 (2-27)	16 (9-26)
Clutch size (Average and range)	2.59 (2-4)	2.01 (1-3)	2.21 (1-3)	2.17 (2-3)
Initial brood size (Average and range)	2.29 (0-4)	1.90 (0.3)	2.19 (0-3)	2.00 (0-2)
Number fledged (Average and range)	2.13 (0-4)	1.84 (0-3)	2.11 (0-3)	1.25 (0-2)
Brood quality (Mean rank and SE)	2.06 (0.25)	1.53 (0.16)	2.07 (0.14)	1.80 (0.16)

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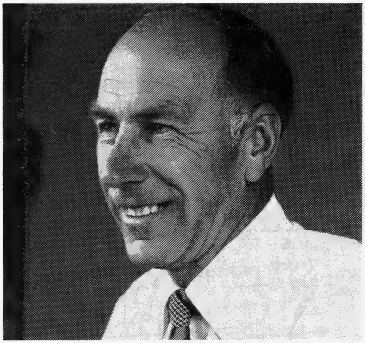
OBITUARIES



MALCOLM CASTLE
1923-1996

The death of Malcolm Castle not only means the loss of a friend, but also the end of an era for the Ayr Branch - Malcolm was the last of the founder members still coming to our meetings. Throughout this period he always maintained close links, from being the first Branch Secretary, through his chairmanship in the 1970s and, latterly, as President. His enthusiasm for birdwatching was always apparent from his questions at meetings and he was a regular on our outings, especially the longer trips.

He was always keen to help with survey work. This was never clearer than in his role as the Ayrshire organiser during the 5 years of field work for the first BTO Breeding Bird Atlas. However, for many, his name will always be linked with rookeries. He first organised a survey of the county in 1966, inspired by the pioneering work of Robert Walls 10 years earlier, and then kept up the counts each decade, sometimes linking with BTO surveys, until the year of his death. It is only a matter of months since he last sent us out with our maps and clipboards. His loyalty to Rooks combined his love of birds and his professional interest in agriculture, in a species that acts as an excellent indicator of the general health of the countryside.

As a scientist, his many years of research at Shinfield and then at the Hannah Dairy Research Institute made him a leading expert on grassland management and silage production. This was recognised in his period as President of the British Grassland Society. His combination of practical agricultural knowledge and concern for wildlife again came to the fore when he played a major role in the formation of the Ayrshire Farming and Wildlife Advisory Group.

Away from work - and birds - Malcolm was a man of many parts. When he came to Scotland he discovered curling, an enthusiasm which remained with him for the rest of his life. After many years of breeding Jack Russell terriers, Malcolm and Betty decided that when they moved to their retiral home at Tobergill they had room for something bigger. It was not long before their little herd of Belted Galloway cattle started to make an impact at the local shows! He also took pride in his skills as a handyman and, after visiting St Kilda with a National Trust workparty, he liked to tell people that he had added stone masonry to his repertoire.

However, the overriding memory of Malcolm for most of us will always be of a good friend, whose infectious enthusiasm for life brightened any day. Whether we remember his comments in meetings or his jokes in the minibus in Islay or Holland, we shall all miss him.

Roger Hissett

ROBERT "BOBBY" JOHN TULLOCH, MBE 1929-96

He was a rare character, one of the kind remembered with a smile. Always known as Bobby, he could amuse and inform without seeming to in his beautiful, soft Shetland accent. At the premiere of the RSPB film on Shetland *Land of the Simmer Dim* in a packed Usher Hall, Bobby walked onto the stage. There was complete silence as he looked around the vast hall and then slowly said "I think there are more people here than in the whole of Shetland". The 2,000 people responded hugely and warmly.

Born in North Aywick, his upbringing was at one with his natural surroundings. At primary school, all the children had "pets" - gulls, crows or waders - all taken as chicks, carefully nurtured for weeks until they could fly. There could be problems, as when his mother found young Bobby tucked up in bed with a young Raven under the covers! Bobby was remarkably surefooted and this stemmed from when he and his school chums ran races along boulder beaches, jumping from stone to stone at breakneck speed - "more interesting than a sandy beach" he told me.

One of the characteristics of Shetlanders is the love of doing something new and the dislike of repetitive work. Bobby, a baker by trade, started up a travelling shop. He bought an old van and spent a long time carefully painting one side with his name and pictures of his products. However, he only did one side; "too routine", he told me, to do the other.

During the 50's and early 60's, all his spare time was spent studying the wildlife around him and increasingly the RSPB used his results and expertise. In 1964, the late George Waterston made him an offer he could not refuse; to be Shetland representative for the Society. For 21 years his achievements for conservation and public relations were truly outstanding. He built up a data base of birds, developed several important nature reserves and stimulated local people to take a pride in their islands. Undoubtedly the first breeding of Snowy Owls on Fetlar (1967) was the highlight of his career. For 4 years he threw himself into organising the protection and viewing of the famous pair and he developed enormously during this time, gaining a confidence which never left him.

Bobby was a remarkably talented man. He was an accomplished musician on guitar, fiddle and accordian, much in demand at any social gathering, and a self taught photographer of outstanding quality. He often processed his own film, both print and slide, and I remember being in his little dark room and seeing a lot of slides in the waste bin. "Oh, they're not good enough" he declared. These rejects I used for many years of lecturing! Bobby's own talks were legendary. Photographically superb, he blended these together with anecdotes and observations which were classic examples of pure entertainment and education. At SOC Conferences he was the centre of a rollicking crowd at the bar, always with laughter as Bobby was a great raconteur. On Saturday evenings the call would go out and soon he was on a chair with his squeeze-box surrounded by happy dancers. Great weekends!

In 1969, Bobby started the Shetland Bird Report and 4 years later he and Dennis Coutts established the Shetland Bird Club. He was elected the Club's President and remaind so until his death. After retiring from the RSPB, Bobby had the freedom to travel. He regularly lectured on National Trust for

Scotland cruises and led tours throughout the world, from the Arctic to Antarctica.

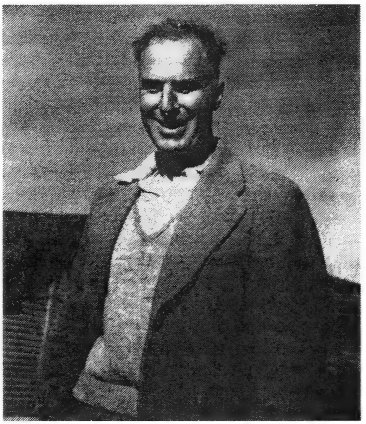
Bobby enjoyed writing but his early publications were also important for bird conservation and showing his fellow Shetlanders just how vital their islands really were. Many people considered his *Bobby Tulloch's Shetland* to be his finest book, giving an insight into how he viewed the natural world, illustrated with his expressive photographs. This book also reflected his deep, alround knowledge of Shetland's natural history, particularly of Otters and seals. Several TV films would never have been possible without his intimate local knowledge.

Other examples of his breadth of interest were his photographs of flowering plants and ferns, while for his own interest he built up a considerable list of fungi for the islands - all of which, he assured me, he had eaten.

After an illness, Bobby died peacefully in Lerwick. His wife, Betty, had died some years previously. Everyone who had ever spoken to him and, I reckon, had even heard him speak, considered him a friend. We all miss him and we are grateful he shared his world with us.

Frank Hamilton

VERO COPNER WYNNE-EDWARDS
CBE FRS FRSE 1906-1997



1946 was a year of new beginnings. The world was recovering from the trauma of war and hundreds of thousands of men and women were returning home optimistically to face the future. In that dawn there was a fresh sense of freedom which brought with it a rediscovery of nature and a new ideology called "conservation". Millions who had forgotten the sights, sounds and scents of their native land, had a new found value of all things natural and from their ranks came champions in the name of natural science. One of these was Vero Wynne-Edwards, a man of great intellectual and physical energy, a pioneer of modern marine ornithology, an explorer of the Canadian Arctic and a fundamental thinker.

That year, Wynne-Edwards was appointed to succeed Alistair Hardy to the Regius Chair of Natural History in Aberdeen University. Wynne, as he was widely and affectionately known, was 40 years of age. Like other students of zoology of his time, at Oxford he did the long march through the Animal Kingdom and graduated with First Class Honours in 1927. Unlike most postgraduates, who became specialists in a narrow field, he chose a broad canvas of biological experience and scholarship, and this determined the wonderful personality he was to become. His first venture was in marine research when he worked on Herring, Cod and small crustacea, with a side interest in the behaviour of wintering flocks of Starlings. In 1929 he became a lecturer at Bristol University and married Jeannie Morris. About this time he was studying Lapwings in a large meadow when, from his hide, he was horrified to see a squadron of cavalry trooping through the gate. Rushing forward he addressed the Colonel at the head of the column. "Sir, this field is alive with nesting Lapwings and their chicks... could you please return in a month's time?" So instantly convincing was Wynne's plea that, to the consternation of the troopers, the Colonel turned his charger and led the squadron back through the gate.

In 1930 he became an Assistant Lecturer at McGill University, Canada. He became interested in Atlantic ornithology and produced the hypothesis that seabirds were not randomly distributed across the trackless face of the ocean. His interest in alpine flora, which he had had from his childhood in his native Yorkshire Dales, blossomed in Canada with published papers on the patchy distribution of rare flora. For these works he was twice awarded the Walker Prize of the Boston Natural History Society and the Fellowship of the Royal Society of Canada. During the war, he organised a course in electronic physics for radar mechanics in the Royal Canadian Air Force and was sent to assess the fisheries of the Yukon and Mackenzie rivers.

After 15 years of happy and exciting life at McGill, Canada was in the blood of the Wynne-Edwards family. Their daughter Janet and son Hugh were both born in Canada and returned there to settle in later life. One of the attractions of the Aberdeen job was the fact that it provided 5 months home based skiing in most years! In 1950 Wynne returned to Canada as the zoologist on the Baird Expedition to Baffin Island.

In 1946 George Waterston, Arthur Duncan and others were reviving the Scottish Ornithologists' Club and Wynne-Edwards arrived just at the right time. He provided an instant link with centres of learning in natural science at home and abroad. He also gave professional academic backup to what was essentially an amateur movement out of which, very shortly, was to emerge the professional cadre of natural scientists who would forge the basis of nature conservation in Scotland. In the choice, training and deployment of these scientists in public life he was to play a leading part in conservation over the next 25 years. Though Wynne was a classical zoologist of the old school, devoted to scholarship, he was also a pragmatist with a rare insight into the ways in which science can be put to the service of the community. One of the many outlets of his talents and energy was the SOC. He became an Hon. Vice President and joint founder of the Aberdeen Branch of the Club, a Trustee of the Fair Isle Bird Observatory and the chief editor of the resurrected *Scottish Naturalist,* a connection which lasted until 1964 when he became co-editor of the new *Journal of Applied Ecology.*

His intellectual life was greatly tempered by his desire for physical fitness, coupled with a love of the mountains and wild country. He became a life member of the Cairngorm Club and was a leading figure in the Aberdeen Branch of the Scottish Ski Club. At the age of 62 he broke the record for a traverse on foot of the 6 main summits of the Caringorms by 96 minutes. True to character, he would appear at meetings in shorts having run the distance while others travelled by car. With brief case in rucksack, he walked across the Mounth and Lairig Ghru to meetings in Tayside and Speyside. He ran regularly on hill and shore, plunged in river and sea at all seasons, and often cycled to the mouth of the Don to have his picnic lunch while botanising and bird watching.

Wynne-Edwards' main endeavours were focussed in the building of one of the finest university departments of zoology in Europe. He took the entire establishment from its old quarters in Marischal to the new building in Old Aberdeen in 1970 and he founded the Culterty Field Station at Newburgh in 1958. The pre-eminence of Aberdeen zoology rested largely upon Wynne's scientific reputation which was greatly enhanced by his highly controversial challenge to Darwinian orthodoxy. In his great work *Animal Dispersion in Relation to Social Behaviour (1962),* he proposed that animals cooperate for the benefit of the group, that they compete for territory and status rather than food, with the losers having to accept their lot. He stated that animals are not, as Darwin supposed, always striving to increase their numbers, but are instead programmed to regulate their numbers. Group selection he saw operating in the differential survival of populations. A precis of the book in the *Scientific American* in 1974 sold 350,000 copies.

The theory was roundly rejected but Wynne was never persuaded that he was wrong. After 25 years of debate, when he was 80 years of age, he published his second work

Evolution Through Group Selection (1986). He took his belief in group selection to the grave and is recognised today as one of the most important fundamental biologists of this century having "done a great service in forcing people to think carefully about the evolution of social behaviour, especially altruism" (Krebs and Davies in *Behavioural Ecology: an Evolutionary Approach,* 1978, p8).

Wynne's contribution to science in public life was prodigious both locally and nationally. His influence was inspirational and ranged from the careers of individual students and scientists to the movements of Government policy, affecting the lives of millions. He was in at the birth of nature conservation in Britain and became a long standing member of the Nature Conservancy and its Scottish and Scientific Policy Committees. In 1956 he initiated a research project on the population ecology of Red Grouse, which led to the setting up of the research station at Hill of Brathens, Banchory, and this is still in progress. This served as a prelude to his appointment as a member of the newly created Natural Environment Research Council in 1964. He was later to become its Chairman in 1968-71 - a very difficult time in NERC which resulted in the split of the Nature Conservancy into the Nature Conservancy Council and the Institute of Terrestrial Ecology in 1972. He was also a Vice Chairman of the Red Deer Commission 1959-68, President of the Scottish Marine Biological Association 1967-73, the British Ornithologists' Union 1965-70 and of Section D of the British Association for the Advancement of Science in 1974. He was a member of the Advisory Committee on Fishery Research and the Royal Commission on Environmental Pollution and a Leverhulme Fellow 1978-80. He held honorary membership of 5 biological societies. He was elected a Fellow of the Royal Society of Edinburgh in 1950, the Royal Society (London) in 1970, and was awarded 3 medals: the Neill Prize of the RSE, the Frith medal of the Zoological Society of London and the Godman-Salvin medal of the BOU. In 1973 he was appointed a CBE but many felt that he deserved a greater accolade.

In the formal setting, Wynne-Edwards was the polished, dignified academic, but he had within him other dignities - the sensitive instincts, wonder and burning curiosity of the naturalist and the love and devotion of the family man with 7 grandchildren and 7 great grandchildren. His memorial takes physical form in the Department of Zoology with its Culterty Field Station in Aberdeen University. In science he will be remembered for his Theory of Group Selection, which might gain greater acceptance in future than it did in his lifetime. In education, a generation of natural scientists were fired by his example, enlightenment and romantic spirit. In human affairs, his influence will live on in that great cultural movement which seeks enduring harmony between man and nature.

Information contained in this obituary has been provided by Professor David Jenkins, Dr Adam Watson and Professor Paul Racey, to whom Professor Wynne-Edwards was mentor and friend.

J Morton Boyd

Advice to Contributors

Authors should bear in mind that only a small proportion of the *Scottish Birds* readership are scientists, and should aim to present their material concisely, interestingly and clearly. Unfamiliar technical terms and symbols should be avoided wherever possible and, if deemed essential, should be explained. Supporting statistics should be kept to a minimum. All papers and Short Notes are accepted on the understanding that they have not been offered for publication elsewhere and that they will be subject to editing. Papers will be acknowledged on receipt and will be reviewed by at least 2 members of the editorial panel and, in some cases, by an independent referee. They will normally be published in order of acceptance of fully revised manuscripts. The editor will be happy to advise authors on the preparation of papers.

Reference should be made to the most recent issues of ***Scottish Birds*** for guidance on style of presentation, use of capitals, form of references, etc. **Papers should be typed on one side of the paper only, double spaced and with wide margins; 2 copies are required and the author should also retain one.** We are happy to accept papers on Applemac computer discs. We cannot handle other formats because both the SOC computers and those at our printers are on the Apple system. Please contact Sylvia Laing on 0131 556 6042 to discuss this. Headings should not be underlined, nor typed entirely in capitals. Scientific names in italics should follow the first text reference to each species. Names of birds should follow the official Scottish list (*Scottish Birds* Vol 17 : 146-159). Only single quotation marks should be used throughout. Numbers should be written as numerals except for one and the start of sentences. Avoid hyphens except where essential eg in bird names. Dates should be written:.....on 5 August 1991.....but on the 5th (if the name of the month does not follow). Please note that papers shorter than c700 words will be treated as Short Notes, where all references should be incorporated into the text, and not listed at the end, as in full papers.

Tables, maps and diagrams should be designed to fit either a single column or the full page width. Tables should be self explanatory and headings should be kept as simple as possible, with footnotes used to provide extra details where necessary. Each table should be on a separate sheet. Maps and diagrams should be in Indian ink and be camera ready, but drawn so as to permit reduction to half their original size.

Human induced increases of Carrion Crows and gulls on Cairngorms plateaux by **Adam Watson**. *Scottish Birds* 18(4):206 - 207

Parts of these 2 paragraphs were omitted by the printer.

Since 1970, I have seen Crows on most parts of A south to Ben Macdui summit, but mainly on north parts on and near Cairn Gorm. I counted Crows and people on 30 parts. Out of 7 where I saw no Crows, 5 were among the 6 parts where I saw nobody. Parts where no Crows and people were seen lay away from the main walkers' routes to and from Cairn Gorm, Ben Macdui and Cairn Lochan, mostly on steep rough bouldery corries. On the 30 parts for all 46 years combined, Crow and people densities were related (n-30, rs=0.69)

The highest Crow density (23.2 per ha in 1971-88) was at Lochan Buidhe (next paragraph) followed by 3.4 at the March Burn nearby, Cnap Coire na Spreidhe near the Ptarmigan Restaurant (1.1), Coire Domhain (1.0, associated with garbage at snow holes), Cairn Lochan (0.7), Ben Macdui summit and west of Cairn Gorm (0.6), and lower elsewhere.

Corrected copies of the complete paper can be supplied by contacting Sylvia Laing at 21 Regent Terrace, Edinburgh EH7 5BT.

NEOTROPICAL BIRD CLUB

Neotropical bird club launched

A club has been launched to promote the study and conservation of the birds of the Neotropics (South America, Central America and the Caribbean). It is currently seeking founder members to help reach the launch budget of £2000, which is required to get the club running and to publish the two first issues of its intended journal 'Continga'. Founder members will be asked to pay a minimum of £25, and will be formally acknowledged in the first issue of 'Continga'. 'Continga' will provide a colourful and much needed forum for exchange of information on the avifauna of this extremely rich and diverse area, and will contain papers and features on the birds and their conservation as well as news of recent observations and discoveries (at present, new species are still being discovered at the rate of more than two a year). It is hoped that in due course the club will be able to provide direct funding and support for practical conservation programmes.

For further details and membership forms, please contact:
Rob Williams,
Publicity Officer,
Neotropical Bird Club,
c/o The Lodge,
Sandy,
Bedfordshire SG19 2DL

Scottish Birds

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Two issues of *Scottish Birds* are published each year, in June and in December. *Scottish Birds* is issued free to members of the Scottish Ornithologists' Club, who also receive the quarterly newsletter *Scottish Bird News*, the annual *Scottish Bird Report* and the annual *Raptor round up.* These are available to non-members at a subscription rate (1997) of £36.

The Scottish Ornithologists' Club was formed in 1936 to encourage all aspects of ornithology in Scotland. It has local branches which meet in Aberdeen, Ayr, the Borders, Dumfries, Dundee, Edinburgh, Glasgow, Inverness, New Galloway, Orkney, St Andrews, Stirling, Stranraer and Thurso, each with its own programme of field meetings and winter lectures. The Waterston Library at the Club's headquarters at 21 Regent Terrace, Edinburgh EH7 5BT is the most comprehensive ornithological library in Scotland, and is available for reference during office hours (Monday to Friday, 0930-1630 hrs). (But please phone beforehand).

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The illegal persecution of raptors in Scotland

A report from the Scottish Raptor Study Groups

Extended summary

This document uses data from the files of the Scottish Raptor Study Groups to give examples of the scale and widespread nature of human interference with raptors. Where the data are sufficiently detailed we quantified the levels of impact by comparing breeding performance and numbers in places where raptors are apparently unmolested with places where human interference has been shown to occur.

In south east Scotland human interference occurred at both lowland and upland Peregrine breeding sites, but particularly at those on or adjacent to moorland managed for grouse shooting. At the lowland sites, recorded human interference involved the robbing of about one fifth of breeding attempts with an estimated loss of 19% of the production of young. At grouse moor sites, we recorded nest robbing, nest destruction and/or the killing of adults in about half of nesting attempts reducing potential production of young by at least 33%. Taking into account the reduced occupancy of sites, the estimated loss was 52%. At other upland sites, human interference involved nest robbing in about a third of first nesting attempts resulting in an estimated loss of 3% of overall production. In the whole study area, human interference was probably responsible for the loss of about 27% of potential production of young in the years 1990-96.

At Peregrine nests in north east Scotland human interference was involved in failures at 8-22% of nesting attempts each year up to 1991, and has continued since. It was frequent on 2 estates leading to the loss of about 74% of the production of young. On 2 other estates persecution was less frequently recorded and was probably responsible for a loss of 12% in production. Persecution remained unrecorded on 3 further estates. The overall loss of production of young in the area, attributable to persecution, was at least 24%. No account could be taken of losses due to lowered occupancy or reduced population expansion resulting from low production and the killing of full grown birds.

In central Scotland each year a similar number of Peregrine sites were

checked on keepered and unkeepered ground. There was little difference in the pattern of occupancy of these sites but a large difference in their productivity, those on keepered ground producing 38% fewer young than those on unkeepered ground. This was not because keepered ground was particularly poor in food but was due to the large number of breeding attempts that failed completely at 6 sites, suggesting intensive human interference with a third of Peregrine pairs in keepered areas. Were this the case, human interference was affecting about one fifth of the Peregrine breeding population in central Scotland, reducing overall production of young by about 18% in the years from 1981 to 1996.

In the Highland Council area there is circumstantial evidence of the effect of poisoning on the distribution of breeding Golden Eagles. Illegal poisoning in the northern half of Badenoch and Strathspey coincides closely with a conspicuous lack of breeding eagles in suitable habitat that has held nesting pairs in the past. A similar gap in Golden Eagle distribution occurs in east Sutherland where there have also been recent cases of poison abuse. It is likely that between 10 and 20 Golden Eagle ranges are affected.

In Tayside, the breeding performance of unmolested Golden Eagles in 15 ranges was high. Performance was lower at 3 ranges due to egg robbing, and poorest at 14 ranges where other human interference (poisoning, trapping and shooting) occurred and at 5 ranges on moorland managed for Red Grouse. On the basis of breeding performance figures for unmolested ranges we might have expected an average of 21.6 eaglets to fledge in the Tayside ranges each year, but average production was 12.3, about 43% less.

In north east Scotland, 21 Golden Eagle ranges have been monitored. Fifteen are on ground mainly managed for deer and are relatively successful (0.64 young/range/annum, 1990-96). The remaining 6 are on ground managed for Red Grouse with some plantation forestry and have poor production (0.26 young/range/annum, 1990-96). Here there was intermittent occupancy by Golden Eagles in immature plumage, poisoning and nest destruction, but at 3 ranges persecution has apparently ceased with pairs surviving to breed successfully. Assuming that all ranges could produce 0.64 young/range/annum, an average of 13.4 eaglets would have fledged each year from the 21 ranges in the area, but existing production of 11.2 eaglets was 17% less. Within the existing population there are also gaps where there is suitable habitat, suggesting that at least 2 more breeding pairs could exist if the population were allowed to build up.

In Argyll, the occupancy of Golden Eagle ranges was high and success reasonably good but some persecution occurred. In south Argyll over a 25 year period, up to 3 of 19 ranges suffered persecution in any one year. Had such human interference not taken place we would have expected 7% more successful breeding attempts (equivalent to 19 more eaglets fledged) during this time. This is a minimal figure as only known instances of persecution were used in calculations; suspected instances were not included nor were those ranges where pairs have disappeared.

On 3 moors in south west Scotland, Hen Harrier breeding success and/or numbers increased after persecution ceased. Such an increase was at odds with trends on managed grouse moors elsewhere, where harriers were formerly present. By 1996, there was decline, in places virtually to extinction, in parts of the Outer Isles, in the Ladder Hills and the Cabrach/ Fiddich/Glass area (Grampian) and in Kincardineshire.

The results are discussed briefly, an appendix catalogues examples of the persecution of Golden Eagles in Tayside and another details persecution at a communal roost of Buzzards and Ravens.

Introduction

In the 1950s and 60s, raptors were scarce in Britain as a result of past persecution and the effect of pesticide pollution (Newton 1979). Through the 1970s and 80s raptors increased as a result of the combined effects of special protection and the alleviation of pesticide poisoning. However, despite legal protection, the killing of raptors continues, including the poisoning, shooting and trapping of full grown birds and the destruction of nests and their contents (da Prato & Laing 1996) leading to recent population declines in some areas. Persecution occurs mainly because some people believe that raptor predation interferes with their interests. Specifically, raptors are accused of reducing the abundance of gamebirds for shooting and of killing racing pigeons and other breeds of domestic pigeon. Though less common than in the past (Morton 1995, Ratcliffe 1993) there is also still a problem with the illegal removal of eggs by egg collectors and of eggs and young to be reared for captivity.

The main raptor species concerned are Hen Harrier, Goshawk, Buzzard, Golden Eagle and Peregrine, but other species such as Sparrowhawk and Raven (not a raptor) are affected, as well as some of our rarest birds of prey such as Red Kite, White-tailed Eagle, Marsh Harrier and Osprey. The Raptor Study Groups in Scotland were set up to enable liaison between fieldworkers and other interested parties, mainly to co-ordinate and standardise the monitoring of raptor populations. All the Scottish Raptor Study Groups regularly record the illegal persecution and nest robbing of birds of prey. Instances are given in every annual review, the *Raptor Roundup*, formerly in *Scottish Bird News* and

now a supplement to *Scottish Birds,* and the Groups are convinced that such activities are widespread and even increasing. This paper gives evidence for this and attempts to quantify the problem for some areas and species.

The impact of human interference on the Goshawk population has been assessed in the past by comparing their performance in areas with proven persecution compared with areas where, in the absence of hard evidence, it was thought that there was none (Marquiss & Newton 1982). Though still scarce in Britain, Goshawks have slowly increased and more data on the effects of persecution are now accumulating (Petty & Anderson in progress). Intensive research on Hen Harriers (RSPB and Raptor Study Groups) also compared areas with and without persecution to estimate its effect on harrier populations. The work showed that the killing of adult Hen Harriers and the destruction of their nests was widespread on moorland managed for grouse shooting. This sort of moorland is good harrier habitat so the killing there created a 'sump' effect, recruiting many young harriers from elsewhere and effectively limiting the whole Scottish population (Etheridge *et al* 1997).

In the present paper we also compare areas or nest sites with and without persecution, reviewing recent Peregrine and Golden Eagle breeding data from specific areas where it is detailed enough to allow quantitative investigation. We provide some notes on the localised recovery of Hen Harrier numbers after cessation of persecution on 2 estates in contrast to declines elsewhere. We append documents detailing the recent history of persecution of Golden Eagles in Tayside and an instance of persecution at a communal Buzzard and Raven roost.

1 Peregrines in south east Scotland, east of the A74/M74 trunk road

In this area there are 67 nesting territories or 'sites' recorded to date (1996). We have classified these broadly into 3 categories:
(i) Fifteen lowland sites surrounded by a mixture of land uses but with a high proportion of arable land
(ii) Twenty six upland sites that included unkeepered heather moorland, pasture and forestry ground, and
(iii) Twenty six grouse moorland sites, surrounded by or adjacent to land managed by gamekeepers for Red Grouse shooting.

The number of pairs recorded on nesting territories increased over the last 7 years from 31 pairs (and one single bird) in 1990, to 44 pairs (with 3 singletons) in 1996, but peaked in 1994 at 54 pairs (with 1 singleton). As the population increased more sites became occupied and were added to the inventory of sites to be checked. A few sites remained unchecked in some years including the peak year, 1994, but this was not the reason for the recorded decline, which was largely the result of a fall in the proportion of sites occupied (Table 1.1), particularly on moorland managed for grouse shooting.

The protection afforded to birds on Buccleuch Estates ground meant that some new sites became occupied there but, elsewhere on managed grouse moor, 5 sites previously holding pairs on a regular basis became deserted or occupied only sporadically by single birds. In the other categories of nesting territories (lowland and upland) the pattern was for the occupation of new sites and continued occupancy by breeding pairs at already established sites, only occasionally broken by gaps of one or 2 years apparently associated with a change in birds.

Table 1.1 ***The occupancy of and breeding success at 67 nesting territories of Peregrines in south east Scotland 1990-96.***

Year	Sites visited	Occupied by pair	Occupied by single	Percent occupied by pair	Known breeding attempts	Number of pairs successful	Total young	Young per pair	Failures due to human interfernce (%)
Lowland									
1990	7	7	0	100	6	6	11	1.57	1
1991	10	7	3	70	6	4	10	1.43	1
1992	9	9	0	100	8	7	18	2.00	0
1993	11	10	0	91	8	8	15	1.50	0
1994	15	14	1	93	12	7	22	1.57	0
1995	15	12	0	80	11	10	32	2.67	1
1996	14	12	0	86	12	8	20	1.67	2
Total	81	71	4	88	63	50	128	1.80	5 (8%)
Upland									
1990	14	12	0	86	12	7	16	1.33	3
1991	14	14	0	100	14	8	21	1.50	5
1992	14	14	0	100	12	6	13	0.93	0
1993	17	17	0	100	17	8	19	1.12	5
1994	20	20	0	100	20	15	37	1.85	2
1995	17	16	0	94	15	13	37	2.30	0
1996	18	18	0	100	18	13	34	1.89	1
Total	114	111	0	97	108	70	177	1.59	16 (15%)
Grouse moorland									
1990	16	12	1	75	12	3	10	0.83	8
1991	18	16	1	89	13	5	9	0.56	6
1992	20	15	2	75	11	6	14	0.93	6
1993	22	16	3	73	14	4	8	0.50	6
1994	22	20	0	91	19	9	22	1.10	5
1995	21	15	1	71	14	7	19	1.27	4
1996	23	14	3	61	14	8	26	1.86	4
Total	142	108	11	76	97	42	108	1.00	39 (40%)

The breeding performance of Peregrines also varied between categories of sites, with those sites on or adjacent to grouse moorland producing far fewer young than those elsewhere, associated with the greater incidence of human interference on grouse moorland. The evidence for this interference was usually the disappearance or destruction of nest contents coupled with ground signs of a human visit. The main problem in trying to quantify this fully was that many nest failures did not have accompanying hard evidence of interference, so we could not entirely disentangle persecution from natural nest failure. We tried to estimate breeding performance in the absence of persecution, including natural failures, by comparing the performance of individual sites where there was overt evidence of human interference with those where there was none (Table 1.2).

There were differences in the overall breeding performance at sites in the 3 land use categories, with lowland sites producing more young than upland and grouse moor sites. There were also major differences in breeding performance associated with recorded human interference and particularly poor performance at frequently persecuted grouse moor sites. The relatively small difference in performance between upland sites with and without evidence of human interference was attributable to the low frequency of such

Table 1.2 ***The frequency of known human interference compared with overall breeding performance at 67 Peregrine breeding sites in south east Scotland. Data are from the years 1990 to 1996 inclusive, segregated into sites in the lowlands, in upland and on grouse moor.***

		Number of sites	% breeding attempts lost to known human interference	Breeding performance	
				mean young per attempt	(se)
Lowland					
	interference	5	20	1.66	(0.41)
	interference not recorded	10	0	2.51	(0.24)
Upland					
	interference	8	29	1.63	(0.19)
	interference not recorded	18	0	1.69	(0.28)
Grouse moor					
	interference	16	51	0.45	(0.14)
	interference not recorded	10	0	1.67	(0.41)

A two factor analysis of variance in breeding performance showed significant statistical effects of both land use ($F=5.36, p<0.01$) and whether or not interference was recorded ($F=7.74$, $p<0.01$)

interference, mainly by egg robbings, there and to the fact that this was often followed by a successful repeat breeding attempt. At grouse moor sites the latter was infrequent; interference was rarely followed by a repeat attempt suggesting that second attempts were also destroyed or, more likely, that the adults had been killed. The poor occupancy at these sites and, in particular, the complete absence of adult pairs at 5 of these sites in the last 3 years, suggested that adults were being killed repeatedly or that production was so low that it started to affect recruitment in the last 3 years.

We can estimate the minimum effect of human interference by assuming that, in the absence of such interference, those sites where it was recorded would have produced as many young as those where it was not recorded (Table 1.3). Thus we would have expected 158 young to be produced at lowland sites as opposed to the observed production of 128, 183 at upland sites as opposed to 177 and 162 at grouse moor sites as opposed to 108.

This estimate is minimal because it does not take into account the effect of the killing of adults or the potential effects of low production on subsequent recruitment, both of which would have depressed population increase and reduced the occupancy of known sites by breeding pairs.

Bearing this in mind, a more realistic estimate of the effects of persecution on breeding production might be derived by assuming that the occupancy and proportion of pairs laying clutches at grouse moor sites would have been similar to that recorded at upland sites where killing of adults was not recorded. There, laying pairs of Peregrines were recorded at 95% of sites checked, a much higher figure than that observed at grouse moor sites (68%). If this were the case, we would estimate at least 135 breeding attempts at grouse moor sites between 1990 and 1996, with an overall production of at least 225 young. Observed production over these 7 years was only 108 young, so the loss due to persecution was about 52% of the potential. This would mean that in the overall Peregrine population of south east Scotland the production of 413 young was only 73% of the potential (566 young) in these years.

Table 1.3. ***Minimal estimates of the loss in breeding production of Peregrines in south east Scotland due to human interference.***

	Number of nesting attempts 1990-96	Young produced per attempt in the absence of recorded human interference	Potential production of young	Observed production of young	Loss ascribed to human interference (% of potential)
Lowland	63	2.51	158	128	30 (19%)
Upland	108	1.69	183	177	6 (3%)
Grouse moor	97	1.67	162	108	54 (33%)

In summary, the data on breeding Peregrines in south east Scotland showed that persecution or other human interference occurred in all 3 categories of site, but particularly at sites on or adjacent to moorland managed for grouse shooting. At the lowland sites, recorded human interference involved the robbing of about one fifth of breeding attempts at 5 of the 15 known breeding sites, leading to an estimated loss of 19% of the production of young. At grouse moor sites, recorded human interference involved nest robbing, nest destruction and/or the killing of adult birds in about half of the nesting attempts at 16 of the 26 known breeding sites. This resulted in the loss of at least 33% of potential production of young, but this figure did not take into account the reduced occupancy of sites, particularly in the last 3 years. Assuming a breeding pair occupancy figure close to that of upland sites would increase this estimated loss to 52%. At upland sites, human interference involved nest robbing in about a third of first nesting attempts at 8 of the known 26 breeding sites, resulting in an estimated loss of 3% of potential production. In the whole study area, human interference was probably responsible for the loss of about 27% of potential production in the 7 years 1990-1996.

2 Peregrines in north east Scotland

In this area, as elsewhere in Britain, breeding Peregrines have increased, numbers more than doubling from 1981 to 1991 (Hardey 1991), though less so since then. Breeding success varied between years, apparently mainly influenced by weather as much of the population breeds in mountainous areas where late snow can influence laying and rain the survival of small young. Nevertheless nest robbing and the destruction of nests and adults was also a major influence. Robbing of nests (for eggs and chicks) was less frequent in the 1990s than in the early 1980s, but nest destruction and the killing of adults has increased, being recorded at between 8% and 22% of occupied sites from 1981 to 1991 (Hardey 1991) and since then. Much of this human interference took place on areas of ground managed by only a few estates.

From 1992 to 1995, annual monitoring of breeding has included at least 34 nesting sites on moorland managed for Red Grouse and 32 sites in other upland areas: deer forest, hill pasture and forestry. Each year these sites were checked to see if they were occupied, whether they were successful and, if so, how many young they produced. By comparison with south east Scotland, site occupancy was low (about 70%) and overall breeding performance was poor with no more than 1.14 young per occupied upland site (Table 2.1). The breeding performance on grouse moorland averaged about a third less young produced per occupied site, compared with other upland sites, possibly the direct result of the greater levels of human interference but alternatively it could have been merely due to poor food supply there. This alternative is unlikely because those nests on grouse moorland that were successful produced no fewer young than those at other upland sites in the same year (paired comparison over the 4 years 1992-95, 't'=0.57, df=3, p>0.1).

One of the problems with this comparison was that human interference was associated with particular estates. On some estates it was not confined to grouse moors and on others it was not practised even on grouse moor. We therefore regrouped the data into those derived from the 7 main estates (Table 2.2).

Table 2.1. ***The breeding of Peregrines at sites on moorland managed for Red Grouse shooting compared with those at other upland sites managed for deer, hill farming and forestry in north east Scotland, 1992-95.***

Year	Sites checked	Sites occupied	(%)	Successful	(%)	Young fledged	Young per successful nest	Young per occupied site
Grouse moor								
1992	34	23	(68)	2	(9)	5	2.50	0.22
1993	39	27	(69)	13	(48)	29	2.23	1.07
1994	35	24	(69)	7	(29)	13	1.86	0.54
1995	34	27	(79)	9	(33)	17	1.89	0.63
Total	142	101	(71)	31	(31)	64	2.06	0.63
Other uplands								
1992	32	22	(69)	12	(55)	25	2.08	1.14
1993	34	25	(74)	12	(48)	18	1.50	0.72
1994	33	22	(67)	11	(50)	20	1.82	0.91
1995	35	25	(71)	11	(44)	27	2.45	1.08
Total	134	94	(70)	46	(49)	90	1.96	0.96

Table 2.2 ***The breeding success of Peregrines from 1992 to 1995 on 7 different estates in north east Scotland.***

	Sites checked per year	Number occupied per year	(%)	Number successful per year	(%)	Number young per occupied site	Land use	Recorded human interference
A	5.25	4.00	(76)	0.75	(19)	0.19	grouse	frequent
B	3.75	3.25	(87)	1.00	(31)	0.69	grouse	none
C	5.00	3.75	(75)	1.25	(33)	0.80	grouse/deer	some
D	10.00	6.00	(60)	1.25	(21)	0.33	grouse/forestry	frequent
E	7.50	5.50	(73)	3.50	(64)	1.23	deer	none
F	8.00	6.00	(75)	1.75	(29)	0.96	grouse/deer	some
G	7.25	5.50	(76)	3.75	(68)	1.09	deer	none

There was no significant relationship between the level of human interference with Peregrines on an estate and the occupancy of sites there (ANOVA,F=1.153,p=0.4) but a significant relationship with the numbers of young produced (F=7.86,p=0.04).

There was no significant relationship between the occupancy of sites on an estate and the level of human interference with Peregrines on that estate. However, there were fewer successful nests and far fewer young produced per occupied site on the 2 estates where persecution was frequent (0.26 young/ occupied site) compared with those 2 where persecution was infrequent (0.88) and those 3 where it was not recorded (1.00). Human interference thus probably reduced the production of young Peregrines by 74% on 2 estates and by 12% on another 2, equivalent to a loss of 33 young over the 4 years. There were 106 young produced on these estates in this time so the overall loss attributable to persecution was about 24% of overall potential production.

In summary, recorded persecution at Peregrine nests in north east Scotland involved between 8% and 22% of nesting attempts each year from 1981 to 1991, and has continued since then. It was frequent on 2 estates leading to the loss of probably 74% of the production of young. On 2 other estates persecution was less frequently recorded and was probably responsible for a loss of 12% in production. Persecution remained unrecorded on 3 other estates. The overall loss of breeding production in the area attributable to persecution was at least 24%. No account could be taken of losses due to lowered occupancy or reduced population expansion resulting from low production and the killing of full grown birds.

3 Peregrines in central Scotland

Peregrines have been monitored in one area in central Scotland since 1978. At that time there were only 13 pairs recorded, all in the uplands, and 6 of them on ground managed for game, mainly Red Grouse. As monitoring effort increased with the progress of the study and as the population grew throughout the 1980s, new breeding sites were added until by 1996 a total of 36 different nesting territories were located, 19 of them on keepered ground. The population peaked in 1991 at 29 pairs (15 pairs and 2 singletons on keepered areas) and fell to 15 pairs and 9 singletons by 1996.

Before 1981, only a few sites were checked annually but afterwards to 1996, each year there was a sample of 10 or more eyries examined. The occupancy of breeding sites (proportion of sites occupied by a pair), the average brood size of successful nests and the overall productivity (number of young produced per pair) varied from year to year so these measures of Peregrine performance were compared for keepered and unkeepered ground within years using paired 't' tests (Table 3.1). Keepered ground was defined here as an area where there was at least some element of grouse as opposed to other game keepering or deer stalking.

Each year a similar number of sites were checked on keepered and unkeepered ground. There was no significant difference in the pattern of occupancy of these sites but a large difference in their productivity, those on keepered ground producing 38% fewer young than sites on unkeepered ground. This was not because keepered ground was particularly poor in food because there was little difference in the fledged brood sizes there. Poor production of young on keepered ground was principally due to the large number of breeding attempts that failed completely.

Many such failures were known to be the result of human interference, including the destruction of nests and the trapping of full grown birds, but this was not recorded at all keepered sites. Some Peregrine pairs on

Table 3.1. ***A comparison of Peregrine breeding performance between sites on keepered and unkeepered ground in central Scotland (average annual values for the 16 years 1981-96).***

	Keepered	(se)	Unkeepered	(se)	Paired 't' (df=15)	P
Sites checked per year	13.6		13.6			ns
Occupied by pair	10.6	(0.6)	11.1	(0.4)		ns
Occupied by single bird	2.1	(0.4)	1.8	(0.3)		ns
% occupied	79	(4)	82	(3)		ns
% successful	43	(5)	63	(5)	2.96	<0.01
Mean brood size	2.09	(0.19)	2.35	(0.11)		ns
Young/pair	0.88	(0.11)	1.42	(0.12)	4.09	<0.001

keepered ground appeared to have been totally unmolested. Examination of the overall productivity on a site by site basis showed that productivity was much more variable on keepered ground than elsewhere. Very low production at 6 sites was sufficient to account for the overall reduced production there, suggesting intensive human interference with only a third of Peregrine pairs in keepered areas. Were this the case, human interference was affecting about one fifth of the Peregrine breeding population in central Scotland, reducing overall production by about 18% in the years 1981 to 1996.

4 Golden Eagles in the Highland Council area west of the River Spey

Information on the persecution of Golden Eagles in Scotland is reviewed in Watson (1997). The evidence for poisoning in the Highland Council area is inevitably patchy and incomplete. In recent years, the majority of cases of illegal use of poisons in upland areas have occurred in Badenoch and Strathspey and in east Sutherland. Maps presented in Watson (1997) on pages 34 and 229 provide strong circumstantial evidence on the effect of poisoning on the distribution of breeding Golden Eagles in both these areas. A scatter of confirmed incidents of illegal poisoning in the northern half of Badenoch and Strathspey, notably in the Monadhliath mountains, coincides closely with a conspicuous lack of breeding eagles. This is despite the fact that in terms of food and nest site availability this area is suitable for eagles and certainly has held nesting pairs in the past. Media attention has been directed at this area (Cramb 1993) when individual estates on which poisoned eagles had been found were named. A similar gap in the Golden Eagle range occurs in east Sutherland where again there have been several recent cases of poison abuse. It is likely that 10 - 20 pairs of Golden Eagles continue to be 'displaced' by chronic persecution, notably poison abuse, in the eastern part of the Highland Council area.

5 Golden Eagles in Tayside

Tayside has good habitat for Golden Eagles and could support a large and productive population. At present, between 24 and 37 nest territories are checked annually by the

Tayside Raptor Study Group but many are occupied only sporadically by mainly immature eagles. This situation has persisted for a long time and characterises persistent persecution (Sandeman 1957) which still continues (Appendix I).

The population west of the A9 trunk road includes 21 eagle home ranges and has been monitored since the Golden Eagle national census of 1982. Breeding performance is poor (Table 5.1) but varies much between ranges; only 5 have produced 6 or more young in 15 years. Twelve of the ranges have been occupied consistently by adult pairs, all of them on areas managed for sheep or deer. In total, since 1982 they have produced at least 0.37 young/range/annum. This was despite one range being robbed of eggs by collectors continually, another frequently and another once. If we exclude the sites known to have been robbed, production was at least 0.42 young/range/annum. Without egg robbing we would have expected another 9 eaglets to have fledged over the 15 year period.

In contrast, breeding success on the remaining 9 ranges has been very poor with only 2 young produced over the 15 year period. This was mainly because the sites were intermittently occupied and usually by birds in immature plumage. Occasionally pairs would reach maturity and build nests but within a year or so were replaced by immatures. This suggested that mortality of eagles was high. Six of these ranges were on ground managed for Red Grouse shooting. Persecution of Golden Eagles or other raptors was recorded in 6 ranges, including 2 instances of eagles having been poisoned, one of a shot bird and one instance of the removal of young from a nest. On another range, a dead decomposed eagle was found and at another there was hearsay rumour of an eagle having been poisoned. Had Golden Eagles been allowed to mature and breed unmolested on these ranges we would have expected production to be about 0.42 young/range/annum (as above) and 57 additional eaglets might have fledged in west Tayside over this time.

Table 5.1 ***Breeding performance at Golden Eagle ranges in 2 parts of Tayside, 1982-96, grouping ranges according to levels of human interference.***

	Number of ranges	Breeding performance (young/range/annum)
West of A9 trunk road (live prey less abundant)		
unmolested ranges	9	0.42
ranges robbed of eggs	3	0.37
ranges where actual persecution was recorded	9	0.02
East of A9 trunk road (live prey abundant)		
unmolested ranges	6	0.80
grouse moorland ranges	5	0.08
ranges where actual persecution was recorded	5	0.41

The population east of the A9 trunk road includes 16 home ranges and has also been monitored consistently since 1982. Breeding performance in ranges where there has been no human interference is good (Table 5.1), probably influenced by a more continental climate and the high density of prey such as Mountain Hare, Red Grouse and Ptarmigan (Watson 1997). However, the overall situation is poorer because of the high incidence of persecution (Appendix I).

Over the 15 year period 1982-96, 104 eaglets are known to have fledged from the area. At 6 ranges known to be free from human interference, the average production was 0.80 young per range per annum. In contrast, 5 ranges that included much ground managed for Red Grouse shooting had poor breeding success (2 ranges reared 0.20 young per range per annum) or were occupied by a succession of immature eagles and produced no young. The remaining 5 ranges (on ground that included both deer forest and grouse moor) were almost continuously occupied by breeding pairs but there is strong circumstantial evidence that these were subject to direct interference by gamekeepers. Their breeding production was 0.41 young per range per annum.

In 1988-89 the males in one range were poisoned and shot in respective years. In another range the pair has only succeeded in rearing young in the 2 years when the eyrie was on a high cliff where deliberate interference was difficult. Their favoured eyries were on a lower, less weather vulnerable cliff, but easily accessible to disturbance. The breeding attempts here failed each year when the chicks were hatching or still required brooding. Failure coincided with the head keeper visiting the area to control Foxes. At another range the eyries were in 2 glens that had different keepers. The pair always failed when nesting in the eastern glen where the keeper was known for his dislike of eagles. This man's beat included another eagle range with a history of persecution incidents.

Considering that the productivity figures for unmolested ranges in Tayside were 0.42 young/range/year (west) and 0.80 young/range/year (east) we might have expected an average of 21.6 eaglets to fledge in Tayside each year, but actual production averaged 12.3. Our best estimate was that human interference reduced production by 43% in these years.

6 Golden Eagles in north east Scotland

In the past, the fortunes of Golden Eagles in north east Scotland have varied, this variation being associated with land use and food supply but also with the impact of persecution (Watson et al 1989). In recent years 21 ranges have been monitored. Fifteen of these are on ground mainly managed for deer, and these are relatively successful (0.64 young/range/annum, 1990-96). The remaining 6 are on ground managed for Red Grouse with some plantation forestry and have poor production (0.26 young/range/annum, 1990-96).

These 6 ranges were for many years characterised by intermittent occupancy by eagles in immature plumage. At one range 2 poisoned eagles have been found and on one occasion when a pair survived for at least 2 years, 2 nests that had been built were destroyed. No young have been produced and in 1996 the range was occupied by 2 immature birds. At another 2 ranges there has been no record of a pair in recent years; only single immatures were seen and a dead decomposed eagle was found concealed in a

peat hag. At the other 3 ranges persecution has apparently ceased with pairs surviving to breed successfully. On 2 of these ranges the keepers are well known for their positive attitude towards raptors. On the third, the birds may still be vulnerable as this range spans 3 estates.

If we assume that Golden Eagles on these 6 ranges would have been at least as productive as others in north east Scotland (0.64 young/range/annum) we can calculate that an average of 13.4 eaglets would have fledged each year from the 21 ranges in the area. Existing production of 11.2 eaglets is 17% less than this potential productivity.

Within the existing population distribution there are also gaps where there is heather moorland suitable for Golden Eagles with potential nest sites, suggesting that at least 2 further breeding pairs might exist if the population were allowed to build up.

7 Golden Eagles in south Argyll

In this area Golden Eagles have been monitored since 1964. In Argyll, the recorded range occupancy is high and success reasonably good; at least 85% of monitored ranges have been occupied in the 1990s and about 38% of pairs have produced 0.52 young/pair/annum. However, persecution persists at least in south Argyll where monitoring has been intensive and over the last 25 years, up to 3 of the 19 ranges suffered persecution in any one year. The proportion of pairs producing young varied from year to year but overall was 0.53 in the 11 years when persecution) was recorded, about 14% less than the figure of 0.62 in the other 14 years (Man-Whitney 'U' test, $Z=2.11$, $p=0.035$). Had such human interference not taken place we would have expected 7% more successful breeding attempts, equivalent to 19 more eaglets fledged during this 25 year period.

This is a minimal figure as only known instances of persecution were used in the calculation. Other suspected instances were not included. Moreover, the calculation only includes breeding attempts, ie those where birds were known to have laid eggs. Ranges where pairs have disappeared are not included. At one range the eagles were successful in 9 years from 1970 to 1981, but, in 1983 the chick was removed and in 1984 the incubating bird was seen to be put off by a shepherd during a snowstorm. In 1986 a dead female eagle was found on the nest, and a male nearby later the same year. Since then there has been no nest building on this range and only occasionally have birds been seen.

At another range eagles started to breed successfully but, following allegations of lamb killing, a chick was found dead in the nest and, in 9 subsequent breeding attempts, the eggs were deserted, broken or removed. Ground immediately adjacent to the nest was often set on fire and one nest on bare rock was deliberately burned. Finally, after a winter when there was hearsay evidence that 2 eagles had been poisoned, the range became vacant; despite frequent sightings of birds in immature plumage a breeding pair has not become reestablished.

At another range the breeding success of eagles was related to the locations where they nested. When nesting on an estate managed for sheep, breeding was successful in only the first year. The next 4 years' attempts failed as a chick was shot on the nest and eggs were broken or removed. The pair then moved to nesting on afforested land and on a sheep farm with a sympathetic owner and they were successful in 11 of 12 years.

At 2 other traditional Golden Eagle ranges, birds have failed to establish adult breeding pairs in recent years and persecution is suspected. Where this occurs it is difficult to disentangle the effects of persecution from land use change, principally afforestation, so the full impact of persecution in Argyll, and over the whole of Scotland, will remain unquantified until it stops and breeding eagles achieve their full potential distribution and breeding success.

8 The recovery of Hen Harrier numbers following the cessation of persecution in contrast to overall decline

We can gain some idea of the effect of the removal of raptor persecution when we consider how rapidly Buzzards became abundant following the replacement of poisoning by Larsen trapping (a use of legal cage traps with decoy crows) as the main method of killing crows after an anti-poisoning campaign by SOAFD and the successful prosecution of keepers. Buzzards are now a common sight in most parts of Scotland, and may ultimately reach the sort of abundance that is familiar to anyone who has travelled abroad in Europe. The Scottish Raptor Study Groups have mainly concentrated on the scarcer birds of prey and have not monitored Buzzards systematically over large areas. There are, however, good records of increases of the much scarcer Hen Harrier subsequent to the cessation of persecution.

On an estate in south west Scotland, Hen Harriers were monitored from 1984 onwards but suffered complete breeding failure. In 1988, the RSPB, following representations from the South Strathclyde Raptor Study Group, wrote to the owner regarding persecution and a meeting was held. The situation immediately improved for harriers until the estate owner died in 1992 and shooting on the estate came under new management, whereupon relations between keepers and RSPB and the Raptor Study Group significantly deteriorated. Between 1984 and 1988 there were one to 3 female harriers present each year and only 4 out of 11 nests were successful, with recorded persecution incidents including a shot female found dead on the nest and a dead female which had been poisoned with alphachlorolose. From 1989 onwards numbers improved to peak at 9 females (5 successful nests) in 1992. In 1993 no nests produced young, one did so in 1994 and none since then. Numbers of females attempting to breed on the estate initially remained the same but had fallen to only 4 by 1996 (Table 8.1, moor A).

On another estate in south west Scotland, also following representation from the RSPB, persecution apparently ceased in 1990. At one moor (B) prior to 1990 there were no more than 5 females and overall breeding success was low (one successful nest from 11 attempts). After 1990 success improved immediately (4 out of 7 attempts in 1990-92) and numbers of females increased to 11 in 1994 and 14 in 1996, most of which (85%) produced young.

At another moor (C) on this estate, the fortunes of harriers also improved after 1990. Before 1990 no more than 3 females were present in any one year and only 4 out of 7 nests produced young. After 1990, numbers increased to 10 females in 1994, 6 of which produced young. In 1994 there was some persecution on nearby ground with the destruction of several nests together with the

adult females. Harrier numbers overall fell in 1995 to 5 females which bred successfully in that year, but poorly the year after (2 out of 5 nests were successful in 1996).

In each of these case histories, Hen Harrier breeding success and/or numbers markedly increased after persecution ceased. Such increase was at odds with trends elsewhere on managed grouse moors where harriers were formerly present. For example, there has been a decline in part of the Outer Isles, in the Ladder Hills and the Cabrach/Fiddich/ Glass area (Grampian) and in Kincardineshire (Table 8.1). In the latter county there were at least 15 nests found in 1974 when there was relatively little persecution (Picozzi 1978) but as that study ceased and persecution increased in the surrounding area, there were only 3 nests in 1988/9 (Bibby & Etheridge 1993). A thorough search of all moorland in 1995 and 1996 failed to turn up even a single nest.

Discussion and conclusions

The present document lists only some of the persecution incidents from the records of members of the Scottish Raptor Study Groups. The main purpose of the paper is to relate instances from study areas where the impact of persecution can be assessed. We have shown for 3 Peregrine study areas that persecution is by no means rare. The impact of robbing by egg collectors and others appears to have waned, whereas killing of full grown birds and the destruction of nest contents by game preservers seems to have been maintained or even increased in the 1990s.

It seemed that in south east Scotland about half the Peregrine breeding sites on grouse moor suffered persecution with an estimated 52% loss of productivity. In north east Scotland up to 74% of Peregrine productivity was lost on 2 estates where persecution was commonest. The equivalent figure for

Table 8.1. ***The increase in number of Hen Harriers on 3 moors following cessation of persecution in contrast to declines elsewhere.***

Area		Females and/or nests		(years)			
Southwest	moor A*	1-3	(1984-88)	9	(1992)	4	(1996)
	moor B**	5	(pre 1990)	11	(1994)	14	(1996)
	moor C***	3	(pre 1990)	10	(1994)	5	(1995/96)
Outer Isles		3-4	(1988/89)	0	(1995/96)		
Ladder Hills ***		10	(1993)	4	(1996)		
Cabrach/Fiddich/Glass		11	(1994)	4	(1993)	0	(1996)
Kincardineshire		15+	(1974)	3	(1988/89)	0	(1995/96)

* Persecution ceased in 1989, but recommenced in 1993
** Persecution ceased in 1990
*** Most persecution ceased about 1990

Peregrines on keepered ground in central Scotland was 42%. In any one region only a proportion of the Peregrine population was vulnerable so overall losses were less, though not trivial; 27% of production in the south east, 24% in the north east and 18% in central Scotland. The impact on the overall population is difficult to estimate because the killing of adult Peregrines not only reduces production but drains the pool of potential recruits, preventing population increase and perhaps, at present, causing population declines.The proportion of occupied sites has declined in at least some habitats in all 3 areas.

The fortunes of the Golden Eagle population are even more affected by the loss of full grown birds because eagles take so long to mature and start breeding. In the 3 areas examined, the loss of productivity due to egg collectors was small (an estimated value of 12% in west Tayside) compared with the unquantifiable losses due to the failure of adult pairs to establish successful breeding on some ranges. This affected 9 (42%) of ranges in west Tayside, 3 (14%) of ranges in north east Scotland and 3 (16%) of ranges in south Argyll. These are minimal estimates because gaps in the existing Golden Eagle distribution, where there is suitable habitat but no record of pairs, suggest that the breeding population might be much larger were it to be allowed to build up. At present, persecution on some ranges is continuously removing the potential recruits that might otherwise settle and breed in new areas.

Intensive studies of Hen Harriers (Etheridge *et al* 1997) has shown that this 'sump' effect is real, and is sufficient explanation for the speed with which numbers increased following the cessation of persecution in our examples. A further example of a potential persecution 'sump' for raptor populations is the killing of birds at communal roosts (Appendix 2). Anyone who travels widely abroad soon becomes accustomed to the ubiquity of large birds of prey in many countries but, until persecution ceases in Britain, we are unlikely to become accustomed to it here.

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Appendix I. Examples of persecution of Golden Eagles in Tayside

There have been a number of high profile cases of Golden Eagle persecution in Tayside and adjoining areas in recent years. Bearing in mind the small chance of detecting such incidents, these examples probably represent the tip of the iceberg.

Shooting

1. On 21 April 1988 an adult female Golden Eagle was found dead concealed among rocks near its nest a few miles east of Ben Lomond. An X-ray showed that it had been shot with a shotgun at very close range. The nest was later found to contain 2 cold eggs. The police interviewed the local game keeper who had been threatening to 'get the eagle.'

2. On 7 October 1989 a group of 4 hill walkers was approaching the summit of Glas Maol, Glenshee, when they found the corpse of a recently dead Golden Eagle. The bird was retrieved by RSPB investigators and found to be an adult male which had died due to being struck by a single shotgun pellet which had lodged in its windpipe.

Despite a police investigation no culprit was ever identified and no court proceedings were ever initiated. This bird had died on a National Nature Reserve. The only shotgun activity for many miles in any direction is vermin control connected to grouse shooting and grouse shooting itself.

In April of the previous year the adult male in the same home range had been found poisoned on its nest (see below). In all probability the shot male was the replacement for the poisoned male.

3. On 31 May 1994 a young Golden Eagle was found dead close to the reservoir in upper Glen Lednock. This bird had also been shot. The ring it was carrying confirmed that it had fledged from an Argyllshire nest in the previous summer, a good example of the fate awaiting birds moving into Tayside from the apparently impoverished but revealingly more productive deer forest and sheep walk territories to the west.

A police investigation was again initiated but no culprit was found.

4. On 30 May 1995 a RSPB contract worker carrying out an agreed visit to an estate in Glen Clova discovered the body of an eagle. On X-ray this bird was found to contain over 30 pieces of shot. A post mortem revealed that the bird had almost certainly been shot on the ground, perhaps after an initial injury.

An immediate police investigation followed leading to several members of the public giving information about previously unreported persecution incidents in the area. No one was ever charged over the shot eagle.

The reaction of certain landowners was to attempt to suggest that the bird had been either a tame one, or that it had been "planted" to discredit some unnamed person. There was no evidence to back up either of these claims.

Poison

Poisoning still appears to be endemic in Tayside with SOAEFD, RSPB and Tayside Police aware of dozens of confirmed incidents of deliberate wildlife poisoning which have occurred in or close to Golden Eagle home ranges in the last 2 decades. The most commonly recorded victims are Buzzards, which share a liking for carrion with eagles. Golden Eagles, however, are not usually present in such accessible areas as the more ubiquitous Buzzard so the chances of finding a poisoned eagle are reduced.

1. On 1 April 1982 a contract fieldworker found one of a pair of breeding eagles poisoned by alphachloralose within a mile of its built up nest. This was at a remote location at the extreme west of Tayside at the junction of 3 estates. All estates denied any knowledge but a local shepherd/estate worker admitted to the finder of the dead bird that he used the chemical against crows. This remains the only recorded instance of persecution or poisoning anywhere near the location but it may be significant that this was the last known nesting in this home range.

2. On 14 April 1988 a Tayside Raptor Study Group member, carrying out a routine check on Golden Eagles in Caenlochan National Nature Reserve, found an adult male lying dead on its nest. After a difficult climb, he retrieved the bird which was sent for analysis. It was found to have been poisoned with alphachloralose. A field search by RSPB staff 2 days later turned up a dead hare laced with alphachloralose on a grouse shooting estate neighbouring Caenlochan. Again, all was reported to the police who interviewed the landowner and game keeper of this estate but no charges were brought.

3. In early June 1989 an adult female eagle was retrieved dead from its nest near Drumochter a few kilometres outside the Tayside area. Also in the nest were its 2 dead chicks. Post mortem chemical analysis confirmed that the bird had been poisoned with alphachloralose. This was reported to the police and publicised.

The reaction of the landowner was to try to have the NCC withdraw the Schedule 1 disturbance licence of the RSPB contract worker who had retrieved the bird after watching the nest from a neighbouring estate by telescope. The landowner claimed that the licence was invalidated because access permission had not been granted, but how do you disturb a dead eagle and 2 dead chicks?

Trapping

As with poison, the use of baited traps, usually gin traps, to kill eagles has a long history, with many references to this practice in the literature from the early 19th century onwards. Also in common with poisoning, the practice has not died out as some may claim.

1. Following a report from a hill walker on 13 May 1986, 2 RSPB investigators located a baited gin trap at a moorland pool (a 'drowning set') in an eagle's territory at Glen Tarf, near Glen Tilt. The illegal trap had caught a harmless and legally protected Black-headed Gull, no doubt unintentionally, the traditional targets of this trapping method being Fox, Wildcat and Eagle. The illegal trap was reported to the police. When approached by the RSPB, the estate's representative said 'it must have been an older keeper showing a young one the old methods.'

2. On 12 May 1991 an article in *The Observer* carried a picture story on a baited gin trap found set above Glen Tilt. On being interviewed the landowner's comment was to the effect that the incident was regrettable but understandable. The police were again informed but no charges were brought.

3. On 1 June 1991 a walker from Brighton, again in Glen Tarf, off Glen Tilt, found a live Golden Eagle dragging a gin trap behind it through the heather. On his return to Pitlochry he tried to report the matter but failed to leave site details or a forwarding address with the SSPCA before disappearing. Over 2 months later he wrote to RSPB HQ in England to ask if anything had been done! An immediate field investigation was carried out by Tayside Police and the RSPB but a search of Glen Tarf failed to find the presumably by now long dead bird. Again the estate was investigated by the police and again no charges were brought for lack of evidence. The estate asked for more 'cooperation between the RSPB and the keepers.'

4. On 20 January 1996 a landowner on a small estate which was actively running down its game management, phoned the RSPB to say that a dead eagle had been found in one of its crow cage traps. The bird had been ringed as a nestling in 1995, in a nest that had been subject to an intensive nest watch. The site had been previously plagued by egg collectors and a massive effort by some 100 local volunteers had resulted in this chick fledging, the first successful nesting at this site in 9 years.

This bird's death by starvation, due to the neglect of a legal trap, caused great concern. Crow cages could be officially monitored to prevent such incidents but they remain unregulated. A police investigation found no evidence of deliberate wrongdoing.

5. Finally, in July 1982 a recently fledged juvenile eagle was found in Glen Tilt with a badly broken wing and the main primary feathers missing from the other wing. It is difficult to imagine how this damage might have occurred naturally and human interference was suspected. Considerable force is necessary to extract these feathers and the broken wing was consistent with a foot having been braced on it to give leverage to pull feathers from the other wing.

Concluding remarks

This list of incidents for Tayside could be repeated for other parts of Scotland, and incidents are listed and published as a matter of course by the RSPB. The main point to be

made is that such occurrences are still frequent. No knowledgeable person doubts that illegal persecution of raptors continues, or that it is mainly associated with game preservation. It is, however, difficult to prove in court which individual is responsible in any one case.

Appendix 2. Persecution at a Buzzard and Raven communal roost in Tayside

Some raptors and Ravens gather to roost communally, and, under such circumstances, are particularly vulnerable to persecution. Persecution can kill many birds in a short time and these birds are drawn to the roost from a very wide area; thus the activities of one persecutor can affect a substantial part of the overall population of the species in question. It is thought that Red Kites and White-tailed Eagles were exterminated in Scotland more easily than some other predatory birds because, although they are wide ranging, they often congregate to roost or exploit local food abundance, where they become vulnerable to persecution. It is therefore of some concern that persecution at communal roosts still occurs; it is suspected at some Hen Harrier roosts and is documented here for a Buzzard and Raven roost.

The roost accommodated up to 12 Buzzards and 70 Ravens at any one time and was occupied from at least 1988. On 23 December 1990, shots were heard from the roost wood and regular inspection of the site from then onwards in January 1991 discovered a concealed dead Buzzard and 4 dead Ravens lying in the open. The roost was only occupied intermittently for the next 4 years, perhaps because of the persistent shooting taking place there, but numbers built up in 1995 when intensive shooting started again; a Buzzard injured by shot was found in October 1995 and another dead one in October 1996.

The overall impact of such shooting is impossible to quantify. The small glen where the roost is situated is very good Buzzard habitat and could support several breeding pairs but none have been found there.

Appendix 3. Scientific names

Red Kite *Milvus milvus*; White-tailed Eagle *Haliaeetus albicilla*; Marsh Harrier *Circus aeruginosus*; Hen Harrier *Circus cyaneus*; Goshawk *Accipiter gentilis*; Sparrowhawk *Accipiter nisus*; Buzzard *Buteo buteo*; Golden Eagle *Aquila chrysaetos*; Osprey *Pandion haliaetus*; Peregrine *Falco peregrinus*; Red Grouse *Lagopus lagopus*; Ptarmigan *Lagopus mutus*; Black-headed Gull *Larus ridibundus*; Raven *Corvus corax*; Mountain Hare *Lepus timidus;* Fox *Vulpes vulpes;* Wildcat *Felis silvestris.*

Manuscript accepted September 1997

Publication of this paper has been accelerated as the information is of direct value to the current debate on raptors. We thank the George Lodge Fund for funding an extra Scottish Birds which will be published in March 1998.

Movements of Fulmars from the Firth of Forth

JOHN C DAVIES

Recoveries of Fulmars ringed as chicks in the Firth of Forth were concentrated on the shores of the Firth of Forth, on the East Coast and the Low Countries of the North Sea. Other birds were recovered in the English Channel, the Celtic and Irish Seas and the North Atlantic. One third of the birds were recovered in their first year. Immature birds appear to return to British waters in their fifth and sixth years.

Introduction

Fulmars *Fulmarus glacialis* first bred in the Firth of Forth on the cliffs at Tantallon in the 1930s. They now breed at many other sites including the Isle of May (first bred 1930) and Inchkeith (1948), (Harris *et al* 1987). The Fulmars on Eynhallow, Orkney have been the subject of a long term population study (Dunnet 1991) and recoveries of Fulmars ringed in Britain up to 1975 have been analysed by Macdonald (1977).

Most of the Fulmars ringed in the Firth of Forth have been ringed on Inchkeith by the Lothian Ringing Group and its predecessor, the Edinburgh RG. Fulmars have also been ringed on the Isle of May by the Isle of May Bird Observatory and at Tantallon by individual ringers. This paper presents the results of this ringing and updates a previous report by Poxton (1981).

Method of analysis

This paper is based on 109 recoveries of birds ringed as chicks during the first fortnight of August reported up to the end of 1995. All but 8 of the recoveries refer to dead birds. The birds are assumed to have fledged by 1 September each year, although some will not have fledged as early as this, and the year of recovery is from 1 September to 31 August of the following year. The 4 seasons, autumn, winter, spring and summer refer to the months September to November, December to February, March to May and June to August respectively. Since the Fulmar is a pelagic bird, except when breeding, the place of recovery has been allocated to sea areas rather than countries or regions. East Coast refers to the east coasts of Scotland and England; the Low Countries are the North Sea coasts of France, Belgium, the Netherlands and Germany; Scandinavia is the North Sea coasts of Denmark and Norway and the Skagerrak. The NW Approaches are the Malin Sea, the Minches and the Sea of the Hebrides (Hardisty, 1990). North Atlantic includes the Faroes and Newfoundland, Canada.

Results

The temporal and spatial distributions of

recoveries are shown in Tables 1 and 2 and are mapped in Figure 1. Nearly a third (31%) of all recoveries were from the Firth of Forth and over a third (35%) of the birds were recovered in their first year, mostly within 2 months of fledging. Other recoveries in the first year came from the East Coast, the shores of North Sea and the North Atlantic. The number of recoveries reduced considerably in the second, third and fourth years, again with recoveries from the shores of the North Sea and North Atlantic. In the fifth and sixth years recoveries increased with birds from the English Channel, the Celtic and Irish Seas and the NW Approaches as well as the North Sea and North Atlantic. The majority of birds were recovered in spring and summer. Few were recovered in autumn or winter with the exception of the autumn of the first year.

Figure 1a ***Recoveries of Firth of Forth Fulmars Years one to 4.***

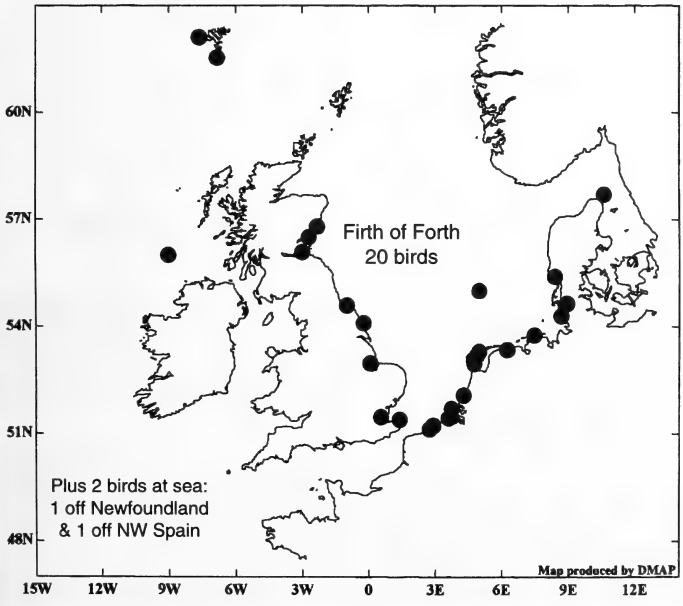
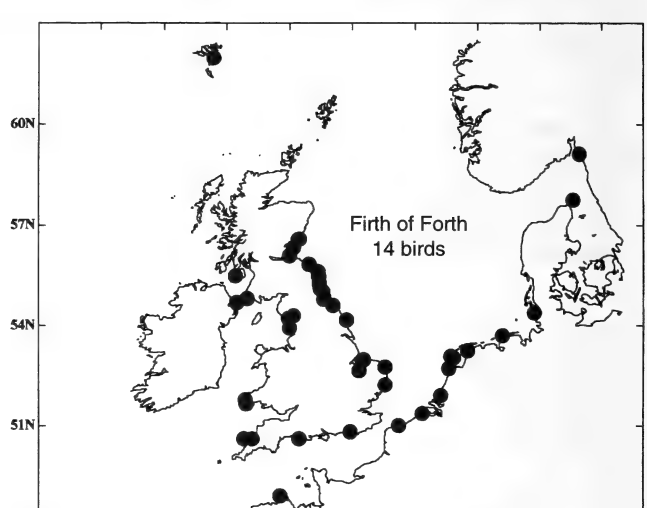


Figure 1b ***Recoveries of Firth of Forth Fulmars Year 5 onwards.***



The finding details of recoveries were divided into 4 main categories shown in Table 3. Almost two thirds (65%) of the birds recovered were simply found dead on the shore. Sick and injured birds (11 %) included birds which subsequently died or were taken into care with unknown results. Oiled birds (8%) could have been involved in an oiling incident or become contaminated after dying. Fulmars suffer insignificant losses from chronic oil pollution except maybe in the southern North Sea (Stone *et al* 1995). Included in the caught or shot category were 8 birds (out of 17) caught and released again by ringers at other colonies; 2 local movements (Tantallon to Inchkeith and Inchkeith to Inchmickery); one to the Farne Islands; 3 to Hunstanton, Norfolk; one to Ile de Rouzic, Brittany, France; and one to the Copeland Islands Northern Ireland. The median age of these birds was 11 (range 6 to 20 years).

There were also 11 recoveries of birds ringed as adults in the Firth of Forth. They were recovered between one and 14 years after ringing (median 4 years). Four of the recoveries were within the Firth of Forth, 5 within the North Sea, one in the Faeroes and one in the Barent's Sea. There were 5

Table 1 Year and area of recovery of Firth of Forth Fulmars.

	YEAR OF RECOVERY																
Area of Recovery	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	14th	15th	Total	Percent
Firth of Forth	20				2	1	1	2	2	3	1			2		34	31%
East Coast	5		2		2	5	1	3	3	1		1	2		1	26	24%
Low Countries	11	1	1	1	2	2	1	1	1			1		1		23	21%
Scandinavia		2		1				1		1						5	5%
English Channel					1		2	1								4	4%
Celtic Sea						1	2		1							4	4%
Irish Sea						2	1		1			1				5	5%
NW Approaches						1										1	1%
North Atlantic	2	1	1	1		1										6	6%
Total	38	4	4	3	7	13	8	8	8	5	1	3	2	3	1	108	100%
Percentage	35%	4%	4%	3%	6%	12%	7%	7%	7%	5%	1%	3%	2%	3%	1%	100%	

Footnote. *One recovery not included: 20th year, East Coast*

Table 2 Season of recovery of Firth of Forth Fulmars.

	YEAR OF RECOVERY																
Season of recovery	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	14th	15th	Total	Percent
Autumn	31	1	1			1		2	1			1		1		39	36%
Winter	2			1	1	1								1		6	6%
Spring	2	2	3	2	1	4	2	3	5	2	1	1		1		29	27%
Summer	3	1			5	7	6	3	2	3		1	2		1	34	31%
Total	38	4	4	3	7	13	8	8	8	5	1	3	2	3	1	108	100%
Percentage	35%	4%	4%	3%	6%	12%	7%	7%	7%	5%	1%	3%	2%	3%	1%	100%	

Footnote. *One recovery not included: 20th year, summer.*

recoveries or controls of birds which had been ringed as chicks outwith the Firth of Forth. Three birds ringed on Shetland, Fair Isle and Orkney were found dead in the Firth of Forth one, 5 and 16 years after ringing respectively. Two birds ringed on Fair Isle and at Tarbet Ness, Moray Firth were controlled on the Isle of May after 13 years and at Tantallon after 14 years.

Table 3 ***Finding details of recoveries of Firth of Forth Fulmars.***

Finding Details	Number	Percentage
Dead	71	65%
Sick/Injured	12	11%
Oiled	9	8%
Caught/Shot	17	16%
Total	109	100%

Discussion

Post fledging recoveries are high in the Firth of Forth because its shores are well populated and accessible and dead birds are easily found and reported. Macdonald (1977) found that, soon after fledging, Fulmars disperse from British waters to the waters of the North Atlantic, Norwegian Sea and European Arctic. This study shows Fulmars from the Firth of Forth disperse south east into the North Sea as well as to the North Atlantic in their first year. Whether they enter the North Atlantic south through the English Channel and Celtic Sea or north by Orkney and Shetland is not known. However, in the first few years, there are no recoveries of Firth of Forth Fulmars from the English Channel and Celtic Sea as there are in later years. Tasker *et al* (1985) found higher Fulmar densities off the east coast of Britain in September and October than in other months and also noted south eastward movements of birds at that time.

Macdonald (1977) showed a contraction in the distribution of Fulmars in the North Atlantic in their fourth year coinciding with the return of pre breeding birds to land. Fulmars from the Firth of Forth appear to return to British seas in their fifth and sixth years. Breeding pairs occupy nest sites for several years prior to first breeding at around 10 years for males and 12 for females (Dunnet 1991). Twenty eight Fulmars ringed on Inchkeith (10 ringed as chicks and 18 as adults) have been retrapped or recovered dead on the island in later years. The number of years between ringing and retrapping or recovery varied between 3 and 19 years (median 14 years for chicks and 2 and 18 years (median 7 years) for adults.

Acknowledgements

I am very grateful to Martin Moss and past and present members of the Edinburgh and Lothian Ringing Groups for their efforts ringing Fulmars over the years. Ian Darling kindly gave permission to use the Isle of May Bird Observatory Fulmar recoveries. The British Trust for Ornithology Ringing Scheme is supported by the BTO, the Joint Nature Conservation Committee (on behalf of, among others, Scottish Natural Heritage) and the ringers themselves. Ringing costs for seabirds are currently subsidised by the JNCCs Seabird Monitoring Programme. The Scottish Ornithologists' Club has supported seabird monitoring on the Firth of Forth islands for many years through its Endowment Fund Grants.

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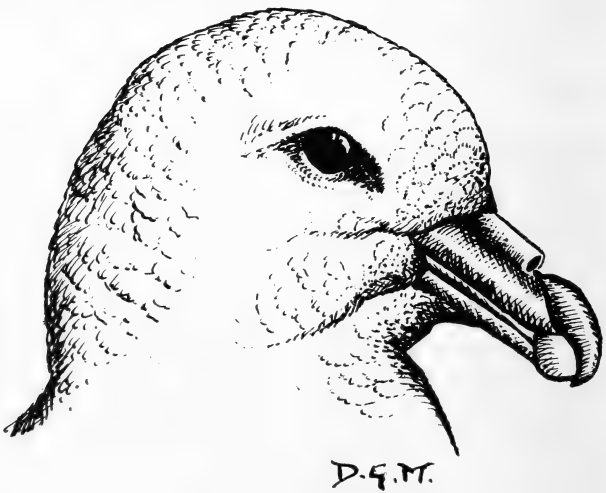


Fulmar *David Mitchell*

A winter survey of sawbill ducks and Cormorants on the River Deveron, north east Scotland.

P J COSGROVE

During January 1996 a winter survey of sawbill ducks and Cormorants was carried out on the main stem of the River Deveron, in north east Scotland. A total of 91 Goosanders were counted representing approximately one bird per 1km of river. Nearly half of the birds were adult males and the rest females or yearlings. Goosanders were most abundant in the lower to middle reaches of the river. No Red-breasted Mergansers were detected on the river. There were 15 Cormorants on the river representing approximately one bird per 6km of river, although birds were only recorded in the lower to middle sections of the river. The figure of 91 Goosanders shows that the River Deveron is a nationally important wintering site, holding at least 1% of the estimated population in Great Britain. However the national population has been estimated in the absence of comprehensive river surveys and so the national figures need to be reassessed to take account of all Goosander habitats. Both Goosanders and Cormorants have been culled under licence in relatively high numbers on the Deveron in recent years. The impact of culling on the bird and fish populations are considered and the necessity of culling is questioned.

Introduction

The aims of this study were to census the winter population of sawbill ducks (Goosander *Mergus merganser* and Red-breasted Merganser *Mergus serrator*) and Cormorants *Phalacrocorax carbo* on the main stem of the River Deveron, from the sea at Banff to the source near Cabrach; compare the counts with other relevant data; assess the likely impact of culling on populations of the respective species, and make recommendations for future censuses of local sawbill and Cormorant populations.

Methods

The winter census of piscivorous birds was carried out by means of a transect count along the whole length (87km) of the River Deveron. The count was carried out in mid January, over 4 days (21.01.96 - 24.01.96) during a period of similarly mild weather conditions, to minimise the possible effects of weather related movements of birds along the river. Goosanders, for example, are prone to cold weather movements (Marquiss, *pers comm)* and therefore selecting consecutive days with similar weather conditions is of considerable importance in avoiding repeat

counts of birds. Counts were usually in the morning but sometimes continued into the afternoon because of short day length. Consultations with local fishermen suggested that human disturbance was not a problem on most stretches of the river outside the fishing season. The towns of Banff, Turriff and Huntly however may have had disturbance during the day; therefore these stretches were surveyed in the first 2 hours of daylight to avoid missing birds which may have been disturbed by human activities along the river. The whole river was walked from Banff to Cabrach, scanning thoroughly at every bend to avoid flushing birds ahead of the fieldworker. The survey was carried out by 2 teams of 2. Observers covered a stretch of river by walking upstream to a predetermined spot where the other observer left a car and began his/her walk. Where possible observers moved around birds so as not to flush them. The location of each bird was recorded from grid references on 1:50,000 maps. Goosanders were recorded and categorised into one of 3 cohorts: paired birds, unpaired adult males and unpaired adult females/unsexed juveniles ('redheads') according to plumage characteristics. Paired birds were defined as males closely escorting females.

Population estimates

Goosander and Cormorant distribution was plotted with respect to river elevation; the whole river was subdivided into 10km sections starting from the mouth. The mean elevation was estimated metres above sea level (masl) from 1:50,000 Ordnance Survey maps. The terms referring population estimates to sections of river are loosely defined as: 'lower' Banff to Turriff; 'middle' Turriff to Huntly and 'upper' Huntly to Cabrach.

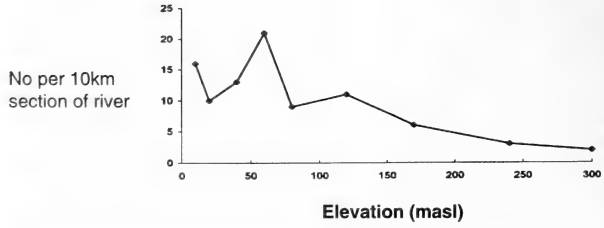
Results

Goosander

Population estimate

Ninety one Goosanders were counted on the main stem of the River Deveron over the 4 day count, giving a density of approximately one bird per 1km of river. During the January count Goosanders were scarce on the upper part of the river and most abundant on the lower part of the river (Figure 1). There were comparatively high densities of individuals in the lower-middle reaches, until 120 masl.

Figure 1 ***Goosander densities in relation to elevation on the River Deveron, in January 1996.***



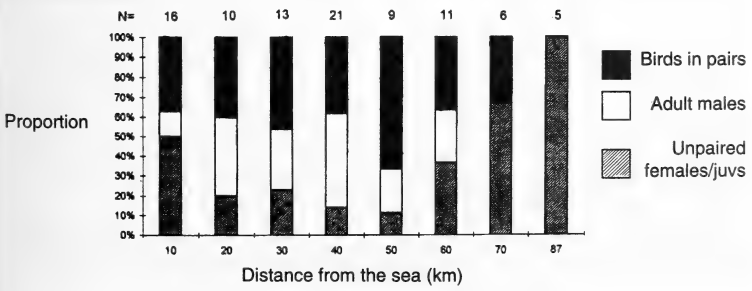
where there was a steady decline up to Cabrach, near to the source of the river (300 masl). The highest density of birds per 10km section was 21 at 30-40km inland, 60 masl around Inverkeithy and Marnoch Bridge. The lowest density of birds per 10km section was 3 at 70-80km inland, 240 masl around Haugh of Glass and Mains of Lesmurdie. There were only 16 birds recorded in the whole of the upper river from Huntly to Cabrach.

Patterns of abundance in the age/sex composition of the population

Nearly half (43) of the 91 Goosanders were adult males and the rest were redheads. Of these birds 36 individuals were in 18 pairs, 30 were single or group redheads and 25 were single or group adult males. The proportions of these 3 categories of Goosanders along sections of the River Deveron are illustrated in Figure 2. The proportion of birds in pairs remained high (30-50%) in most of the lower and middle sections of river. Only in the uppermost reaches of the river were pairs not recorded. The proportion of unpaired adult males remained similar to the proportion of birds in pairs (20-50%) in all but the lowest and upper sections of river. None were recorded in the upper 17km of the river. Redheads were proportionately lower than the other 2 categories in most of the lower and middle sections of the river. However from 60km in land, 120 masl, this increased steadily until the final sections when most of the birds were redheads. In the last 2 sections (17km) of river, Goosanders were very scarce (11 birds) and it should be noted that the changes in composition over these sections are based on small sample sizes.

Goosanders were recorded in small groups throughout the river. Most of the groups tended to be pairs of birds with other individuals in attendance. The highest number recorded in any one location on the river was 7, 2 pairs and 3 additional redheads on one wide, deep pool. There appeared to be no particular bias in the composition of these groups with both adult males and redhead only groups as well as mixed groups being recorded.

Figure 2 ***The proportions of 3 categories of Goosanders seen on the River Deveron in January 1996.***



Red-breasted Merganser

There were no Red-breasted Mergansers detected on the River Deveron.

Cormorant

Population estimates and patterns of abundance

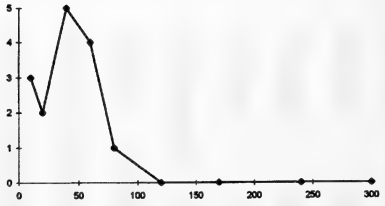
The total count for the 4 days was 15 birds on the river or sitting on tree branches over the river (Figure 3), giving a density of approximately one bird per 6km of river. No Cormorants were detected after Rothiemay, in the middle to upper river stretches. The last bird was seen in 43 km inland, 60 masl, between Marnoch Bridge and Rothiemay. One other Cormorant was found shot dead in a lower river section.

Discussion

Goosander

There have been very few estimates of whole river populations of Goosanders in Britain, most estimates have been made on sections of rivers, such as those counts carried out on parts of the Tweed and Eden in the Borders. Estimates of wintering populations of Goosanders have been compromised by a lack of systematic counts on rivers (Owen *et al* 1986, Marquiss and Duncan 1994). The most comprehensively studied river has probably been the Dee in Grampian. It is perhaps appropriate, therefore, that comparisons are made with this river, although it is acknowledged that the 2 rivers differ in their character with the Dee being a more predominantly upland river than the Deveron. In 1988, the River Dee winter population was estimated from counts in December (Marquiss and Duncan 1994). That study found 62

Figure 3 ***Cormorant densities in relation to elevation on the River Deveron in January 1996.***



Goosanders on the main stem of the river; 20 adult males, at least 8 young males, and the rest females and unsexed young birds. Most birds were on the lower sections of the river, with only 4 birds being recorded in the upper reaches. These results are similar to those found in this study, where most of the birds were on the lower to middle stretches of the River Deveron. Marquiss and Duncan (1994) attributed this to the species' food requirements. Goosanders' main prey items are largely unavailable during the daytime in the very cold upper reaches of the river in winter because many of the fish are apparently buried in the substrate. The birds are consequently found lower down the river on the deeper water where many fish are still available. This was the case in the present study; most birds were found in areas that reflected their needs for food, such as long deep straights, wide sweeping bends and deep pools.

There were some differences in the patterns of abundance of the age/sex composition of the populations between the 2 studies. A greater proportion of birds on the Deveron were in pairs, particularly in the lower reaches, than were found on the Dee where most of the birds were unpaired. This could have been because the Deveron counts were approximately one month later in the season than on the Dee and closer to the breeding season, when more paired birds might have been expected. There were also some apparent differences in the composition of the populations in the upper reaches of the 2 rivers, but these could be explained by the very small sample sizes and any conclusions should therefore be treated with caution.

Systematic counts of birds on the River Deveron appear not to have taken place before, so previous population estimates are not available, but the shooting bags figures from SOAEFD may give some very crude minimum estimates (Table 1). These figures are, however, difficult to interpret because shooting effort was not standardised or even measured. Goosander bag sizes from between 1992-1994 suggest that numbers were probably in excess of 50 birds. Initially the limit was set for 150 Goosander, almost 2% of the national population (Waters and Cranswick 1993). The bag limit has since been reduced to 50 but this is still set at approximately half of the January population estimate. Licences are issued to assist in scaring birds to alleviate perceived high predation pressure. A minimum number of birds can be shot to prevent serious damage (Munro, in Hansard. 1991), but licences are issued as a supplement to effective scaring, exclusion and fisheries management policies and not to achieve an overall reduction in the Goosander population (MAFF 1995). One of the consequences of this is that the practice of widespread culling has not been properly investigated (Wynde, RSPB, *pers comm).* Therefore, any assessment of the long term effects of shooting 40-50 Goosanders per year is purely speculative because of a lack of data.

Goosander numbers in Britain have increased over the last 3 decades, although numbers on the most important site in national terms (the Inner Moray Firth) have declined recently and numbers in the north east of Scotland have not increased (Waters and Cranswick 1993). The figure of 91 Goosanders shows that the River Deveron is a nationally important wintering site, holding at least 1% of the estimated population in Great Britain (Waters and Cranswick 1993). However, the national population has been estimated without comprehensive river surveys, so the national figures and levels qualifying for national and

international significance need to be reassessed following national surveys of all Goosander habitats. It is clearly an important wintering site for this species but no data are available to suggest how important the site is in spring for passage as well as breeding birds. It is not known, for example, how many of the winter birds remain to breed. Work from the River Dee suggests that some birds may well remain to breed.

Table 1 ***Numbers of reported sawbill ducks and Cormorants shot under licence on the River Deveron.***

(Data courtesy of the Scottish Office Agriculture, Environment and Fisheries Department SOAEFD)

Year	Season	Species	Bag Limit	No shot
1992	Spring	C	100	4
		G	150	52
		R	50	Nil
	Autumn	C	40	38
1993	Spring	G	50	41
		R	20	Nil
	Autumn	C	40	38
1994	Spring	G	50	17
	Autumn	C	40	4
		G	40	24
1995	No spring licence application			
	Autumn	C	30	18
		G	50	8

Key: C = Cormorant, G = Goosander and R = Red-breasted Merganser

Assessments of the impact of culling on Goosander (and Cormorant) populations cannot be made without further investigations into their biology. Only a little is known about the biology of Goosanders on the Deveron. Marquiss and Carss (1995) found in an analysis of stomach contents of birds shot on the Deveron in the spring that approximately 80% of the food items were Salmon and Trout parr. They did not, however, analyse the contents of guts collected in the winter.

The numbers of Goosander found from one count may well be of little value. On 2 rivers where Marquiss and Duncan counted sawbills, they found bird abundance varied with river habitat, between seasons and between years (Marquiss and Duncan 1993, 1994). It is therefore strongly recommended that future work be carried out on a number of aspects of Goosander biology on the Deveron. Most importantly, monitoring should be carried out on both the spring and winter populations. It is only through increased monitoring of birds that the effects of the killing on the bird populations could be determined, through carefully designed controlled experiments manipulating the levels of culling over a number of seasons. There would also need to be an adequate number of replicates and monitoring of other factors likely to impact on Salmon stocks.

From both the ornithologist's and the fisherman's point of view, the critical question is whether or not the Goosander population is likely to cause serious damage to the fishery. If it does, the 1996 revision of the Wildlife and Countryside Act demands that all alternative measures to killing must have been tried and found to be ineffective, before considering whether or not culling the birds is likely to alleviate this level of damage. If, as the present evidence suggests, they do not cause serious damage to fisheries (eg Marquiss and Carss 1994), then SOAEFD do not need to issue licences because the question of culling is unnecessary.

Red-breasted Merganser

There were no Red-breasted Mergansers found on the Deveron in the course of this study, nor were there any returns of birds killed in any of the years where licences were issued. However, historically some birds were recorded at the mouth of the river in the 1940's and once a group of 4 were seen at the Alvah gorge (A Watson *pers comm*). It is surprising therefore, that SOAEFD issued licences to kill up to 50 Red-breasted Mergansers on a river on which they were apparently absent.

Cormorant

The count of 15 Cormorants on the whole river is low compared to the numbers shot annually under licence (Table 1). In some years up to 40 birds have been shot. The data on when these birds were shot are unavailable, and as a consequence, it is difficult to assess whether the population of birds was formerly high and has since declined. The Cormorant population in Great Britain as a whole is high and increasing (Waters and Cranswick 1993), but there has been a substantial decline in breeding numbers between the 2 breeding Atlases in some areas, especially in northern Scotland (Gibbons *et al* 1993). It is possible that shot birds have been replaced by new birds from surrounding areas and that the cumulative effect of the birds removal has been rapid re-colonisation of suitable feeding areas on the Deveron.

The distribution of Cormorants inland tends to reflect their choice of feeding areas (Carss and Marquiss 1991, Marquiss and Carss 1994). The birds tend to respond to increases in food availability quickly and colonise suitable areas. The recent rapid increase in small ponds and lochs (*pers obs*) stocked artificially with Trout and other species on and around the Deveron catchment may have provided new concentrated feeding sites formerly absent for Cormorants. Any potential predation problems are likely to be exacerbated by the increasing number of new stocked fisheries, particularly in the upper reaches of the Deveron where Cormorants were not recorded on the river. There is no evidence that the Cormorants shot under licence on the Deveron were actually foraging in the river. Unpublished information from other areas in Britain, suggests that many of the Cormorants that were killed under licence were shot flying above waters, rather than shot when actually foraging in them (Wynde, RSPB *pers comm)*. Several Cormorants were seen above the middle to upper reaches of the Deveron flying quite high upstream. None of these birds were later recorded on the river and it is unclear where their final destination was.

It is difficult to assess what impacts culling is having on the Cormorant population. There is no information on turn over rates of birds or actual foraging rates on the river. However, the removal of up to 40 birds annually from a population with such a low number of individuals in the winter gives cause for concern. Further monitoring of Cormorants should take place (similar to that described for Goosander) on the Deveron to determine the impacts of the cull on both the Cormorant population and the fishery. It would also be useful to have more meaningful shooting bag returns, illustrating the dates when and where birds were shot and whether the birds were on the river or flying over. Only when more information is available can informed decisions be made about fisheries management and bird numbers.

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Cormorant *David Mitchell*

Declines in Turnstones and Purple Sandpipers wintering in south east Scotland

H E M DOTT

Winter counts of shorebirds carried out in south east Scotland on predominantly rocky coasts in East Lothian and Berwickshire have revealed an alarming decline in numbers of Turnstones and Purple Sandpipers since the late 1980s.

Introduction, study area and methods

The coast of south east Scotland from Gullane Point in East Lothian eastwards is exposed and mainly rocky, with some cliffs and many small pockets of sand or stones and a few beaches. In Berwickshire it is still more exposed, steep and rocky, with some major cliffs and fewer beaches of sand or boulders. There is about 60km of coastline from Gullane Point to the border with England.

The status of birds using exposed open coasts in Britain is less well known than that for those using estuaries, which have been monitored regularly through national schemes for more than 20 years. However, for the open coast of south east Scotland a number of counts of shorebirds have been made, and those for Turnstones *Arenaria interpres* and Purple Sandpipers *Calidris maritima* are presented here.

This 60 km stretch of coast was first counted in winter 1973-74 by Summers *et al* (1975), and East Lothian sections were counted in winters in 1976-77, 1977-78, 1979 and 1984 (da Prato & da Prato 1979, 1985).

In January 1995 counts of all shorebirds were made along the entire coast again, omitting only the estuary of the River Tyne as before. This was done by a team of local counters as part of the national WeBS Non-Estuarine Waterfowl Survey Pilot Count 1994-95, organised by BTO, WWT, RSPB and JNCC. Repeat counts on the same stretch of coast were made in January 1996 and February 1997, mainly by the same counters using the same methods. The 3 counts were made by all the team members working concurrently during the same low tides on 8 January 1995, 14 January 1996 and 2 February 1997, except for a small section of the Berwickshire coast done on 7 January 1995 and 13 January 1996, so that the likelihood of double counting or of missing birds was minimised.

In all years low tide counts were carried out within 3 hours before or after low water. Counters were particularly looking out for "difficult" species such as Purple Sandpiper. Full details of the methods are given in Summers *et al* (1975) and in the WeBS Pilot Count 1994-95 instructions. da Prato and da Prato (1979) made comparisons of low and high tide counts made on this coast during 3 winters, and found higher counts were consistently obtained during low tide.

Table 1 ***Numbers of Turnstones and Purple Sandpipers counted on non estuarine coasts in south east Scotland.***

	1973-74 Nov-Feb	1976-77 Dec-Jan	1977-78 Dec-Jan	1979 Jan	1984 Dec	1995 Jan	1996 Jan	1997 Feb
Turnstone								
East Lothian	1,299	1,515	1,633	1,259	1,351	489	411	259
Berwickshire	229	-	-	-	-	33	41	61
Purple Sandpiper								
East Lothian	688	642	659	746	522	63	81	83
Berwickshire	39	-	-	-	-	10	0	17

	Mean 1970s & 1980s (East Lothian only)	Mean 1990's (East Lothian only)	Percentage change
Turnstone	1,411	386	-73%
Purple Sandpiper	651	76	-88%

Results

The most recent counts reveal that the number of Turnstones and Purple Sandpipers have declined very considerably since 1984. Table 1 shows all counts obtained for Turnstones and Purple Sandpipers for the 60 km of coast. For both species the counts are remarkably similar through the 1970s and in 1984, but are dramatically lower in the 1990s. At face value these counts indicate a drop of 73% for Turnstones and 88% for Purple Sandpipers.

Purple Sandpipers have been counted more frequently, mainly by the reserve warden, at Gullane Point-Hummell Rocks, part of Aberlady Bay Local Nature Reserve, at the western end of the open coast, and these counts are shown in Table 2. They suggest a less drastic drop than the Table 1 figures but do also show a decline, particularly from the late 1980s onwards. Annual WeBS counts for the neighbouring Firth of Forth estuary show no clear trend for Turnstones and include too few data for Purple Sandpipers to be meaningful.

Discussion

Turnstones and Purple Sandpipers are known to be strongly site faithful to relatively restricted sections of coast in winter, both within one winter and from one winter to another, and they are unlikely to move due to cold weather as their food is relatively unaffected by frost (Metcalfe & Furness 1985, Summers *et al* 1992, Burton & Evan 1997), although some individual Purple Sandpipers may perform diurnal movements of up to 8 km, at least in April (Summers 1995). This suggests that the results shown in Tables 1 and 2 indicate a real decline in the numbers of Turnstones and Purple Sandpipers wintering in this part of south east Scotland.

The scale and the possible causes of this

Table 2 ***Maximum numbers of Purple Sandpipers counted at Gullane Point-Hummell Rocks, East Lothian, November-March, 1978-87.***

Year	Maximum Count	Year	Maximum Count
1978-79	70	1987-88	21
1979-80	63	1988-89	20
1980-81	111	1989-90	18
1981-82	100	1990-91	23
1982-83	75	1991-92	18
1983-84	75	1992-93	17
1984-85	45	1993-94	20
1985-86	21	1994-95	14
1986-87	80		

decline would have to be examined in the wider context of whatever population these birds may be from. The annual WeBS shorebird counts for the UK (annual *Wildfowl and Wader Counts*) also show some recent declines for both species, but this scheme has been based largely on estuarine shore counts and thus does not adequately monitor total UK numbers. Of all shorebirds in the UK in winter, Purple Sandpipers and Turnstones have the largest proportions occurring on non estuarine shores (Cayford & Waters 1996). These authors, in an analysis of 40 non estuarine UK shore sites, found an *increase* in Turnstones and Purple Sandpipers between 1984/85 and 1991/92. However Browne *et al* (1996) using data from over 500 UK non estuarine sites found *decreases* between 1984/85 and 1994/95 of 44% for Turnstones and 53% for Purple Sandpipers. There is clearly cause for concern and need further investigation if decreases of this order are genuine. The data given here for south-east Scotland are of particular interest due to there having been comparable counts for the same coastline during the 1970s, 80s and 90s.

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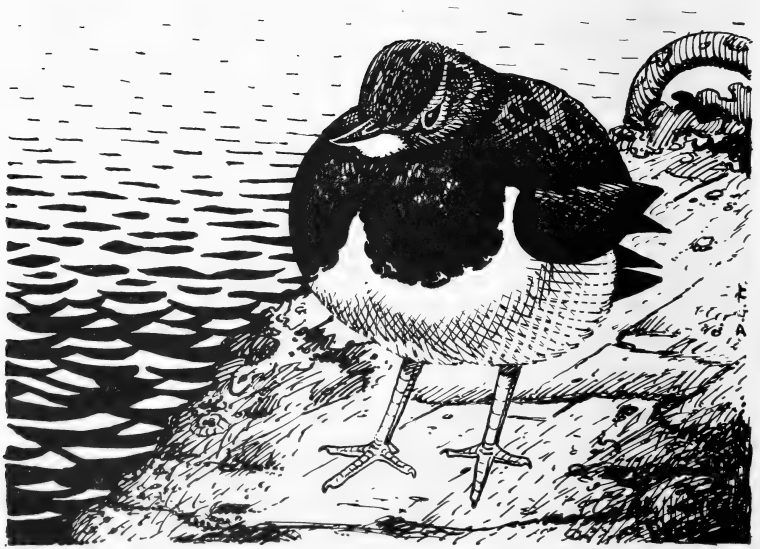


Turnstone in winter plumage *David Mitchell*

Habitat use by Snow Buntings in Scotland from spring to autumn

ADAM WATSON

Adult Snow Buntings fed their young on invertebrates obtained beside snow, and on snow, flushes, and grassland. Adults and independent young often ate grass seeds at reseeded patches on a ski area, and picnic scraps, but scraps were seldom fed to dependent young. Snow patches delayed insect emergence, leading to plentiful food on thawing soil outside the receding snow edge throughout the summer. All habitats used had interlocking boulders, giving shelter to fledglings and cover from predators. Most moulting birds in late August and September were at bouldery hollows, cliffs and summit cairns. Birds in spring, snowfalls before nesting, and October used a far larger area than breeders. This needs recognition for species protection.

Introduction

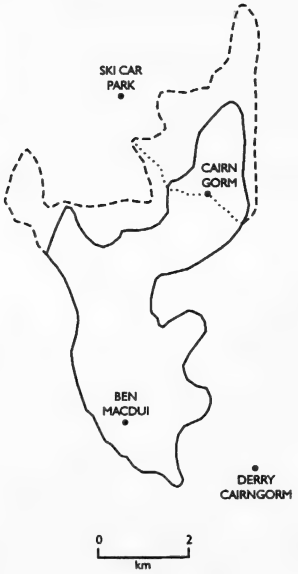
Snow Buntings *Plectrophenax nivalis* in Scotland nest at low density on a southern edge of their mainly arctic breeding range (Perrins 1994). There is much interest in such marginal populations and in understanding their habitats better. I observed on the same area as Nethersole-Thompson (1966), Smith & Marquiss (1994, study of marked birds in 1988-93), and Watson (1996, breeding in 1970-87). I lacked marked birds but they were unnecessary for this particular study. I had a long run of observations from 1943 to 1997, including spring and autumn, seasons for which few data have been published hitherto. Summer winds drop insects on snow (Thornley 1896), where cold traps them as food for insect feeders (Mani 1962). I wanted to test whether birds favoured snow patches or made equal use of habitats of equal area.

Study area and methods

Smith (1994) described the 16km^2 area A in the central Cairngorms, at 1050-1310m on Cairn Gorm plateau 100km west of Aberdeen (Fig 1). When snow covered A before nesting, birds used the 5.5 km^2 B, down to 850m. Arctic alpine land starts at 760m and has many summer snow patches (Watson *et al* 1994).

Bias occurs in studies of habitat use if observers do not visit some habitats, but my walks were designed to cover all parts of A in approximate proportion, for studies of human use and snow patches (Watson 1991; Watson *et al* 1994). A bird is easier to see in some spots, eg on snow than off it, so I used data only after undisturbed flying birds landed. Statistically independent data were assured by randomly taking an observation for a bird in each category (adult cock, adult hen etc), in

Figure 1 ***Area A used in nesting and fledgling periods (solid line), and alpine land on area B (out to dashed line) used when fresh snow covered A in late March-early June snowfalls before nesting, and in October irrespective of snow. Lines are drawn round outermost sightings in 1943-97. Dotted line shows northern boundary of Sites of Special Scientific Interest.***



each period (incubation, nestling etc), each year. I expanded sample size where birds were obviously different ie adults foraging near nests that lay far apart, and dependent fledglings far apart and at very different stages of development).

I did not use surveys of plant communities, as these were designed for a different purpose and observations on the birds indicated their lack of value. Instead, the habitat's physical structure in terms of boulders, snow patches, and small flushes which were not mapped in the plant surveys appeared paramount. I therefore made a simple classification based on knowledge of the birds. I traced habitats from aerial photographs and made ground checks. Most habitats varied in extent each summer as the winter snowpack melted, and between summers following snowy and mild winters, so I compared usage of these habitats only when nearly all snow had gone.

If birds use one habitat much, use of others must be low. Hence I give a probability for only one habitat in each stage of the annual cycle. I treated 2 or more birds seen together as one sighting.

Results

Song posts and nest sites

Most cocks sang on high boulders and a few on cliffs, cairns, boulder shelters, survey pillars, snow fences, pylons, and huts. One sang from a ledge, overhung above and out of sight from the west where he had no neighbours, but overlooking a corrie which held a cock.

Of 47 nests, 44 lay in holes in interlocking boulders and 3 in cliff cracks. None was reused for a second clutch in the same year. Most were within 30m of boulder fields, and all within 100m. Six were on slopes facing west, 3 south, 7 north, and 31 east. Many boulder fields faced west, but most snow patches faced east (Watson *et al* 1994), like nest sites. All nest sites were within 200m of flushes, and within 200m of snow patches as

noted at the start of July (Watson *et al* 1994).

Adults before nesting

In late March and April I saw many birds on area A in mild snow free weather, mostly in flocks but a few paired or single. Some may have been migrants, but a few single cocks sang in spots used for breeding in previous years. When snow covered A completely, I saw birds on B, eg a cock in winter plumage singing on 27 March at 950 m, >1km from the nearest known nest site. Until mid April a few frequented ski ar parks and buildings at 620-670m, outside B. A tape-recorder there at 0520 on 13 April 1975 revealed much song during a snowfall (A Archer-Lock *in litt*). All birds seen in May were paired or single, except for small flocks on days of fresh snow in early May.

Before nesting began, I saw no birds on A during many ski trips on days in May and early June when fresh snow covered all vegetation and soil there. Birds seen outside A were on land where snow cover was incomplete due to wind exposed terrain or lower altitude, mainly on B but also on Derry Cairngorm (Fig 1). Some on B ate picnic scraps at a cafe at 1090m, at summit cairns, and along footpaths and vehicle tracks much used by people (Table 1). Others foraged on reseeded patches, where ground bared by machines or trampling had been treated with grass seed and fertilizer to reduce soil erosion. They ate ungerminated seeds from new reseeding, as well as seeds produced by grass from earlier reseeding

In May and June before nesting, most days were mild, with many snow free patches of vegetation and bare soil, and thawed upper soil horizons on most ground. Birds fed on scraps, reseeded patches and other habitats. On warm days I saw some eating insects on snow. They often took cranefly larvae (*Tipula* spp) on thawing bare soil beside snow. In such conditions, many larvae came to the surface to escape drowning. The upper soil horizons had become waterlogged, due to thaw water being unable to percolate downwards because of frozen lower horizons.

Foraging of adults with nestlings and fledglings

Food taken by cocks to hens on eggs, and by both sexes to nestlings and fledglings was mainly craneflies, but also other flies, beetles, and moths. In a mass influx of aphids I never saw adults get insects so easily (Watson & Stroyan 1984). Foraging adults often ate insects and grass seeds. Many ate cheese, bread, and cake, but seconds later gathered insects for their young. I saw no adult feed picnic scraps to young, except in 1996 and 1997 on Cairn Gorm with nestlings >8 days old and fledglings. I saw no dependent young find and eat scraps for themselves.

Fledglings scattered within 100m on the day of nest departure, each in a hole in boulders, and came to the entrance to be fed. Later they came into the open, but ran or flew to boulders when disturbed, and sheltered under them in rain, sleet and snow. Up to 5 days out, they often gave a food cheep even when no parent was present, but after a week they did this only when a parent was seen or heard nearby. Each fledgling churred when about to be fed, and up to 10-12 days when finding food for itself. At 15 days, fledglings occasionally gave the food cheep from boulder tops, but I saw none fed after this age. Most young foraging in the first week were at edges of boulder patches, but in the second week they went also to other habitats.

Table 1 ***Percentage of sightings of foraging birds on different habitats in 1966-97.***

	n	Picnic scraps^	Bouldery grassland & heath	Snow	Flush	Reseeded patch	Boulder -field edge*	Smooth grassland & heath	Moss on soil	Moss on rock	Beside snow	Grit patch
Adults - snowfall~	32	44[1]	25	0	0	31	0	0	0	0	0	0
- before nesting#	29	24[2]	17	14	14	10	0	0	0	0	14	7
- with nest eggs	51	14	24	10	16	2	2	2	10	6	16[3]	0
- feeding nestlings	52	4	23	15	19	0	2	2	6	10	19[4]	0
- feeding fledglings	68	3	21	10	24	0	1	0	3	9	29[5]	0
- eating, with young@	21	14	19	5	19	5	5	0	5	10	19[6]	0
Fledglings foraging												
- week 1	34	0	3	0	0	0	94[7]	0	0	0	0	3
- week 2	22	0	23	0	9	0	36[8]	0	14	9	0	9
Flocks adults & fledglings	28	7	29	0	14	0	7	0	0	7	36	0
Adults & independent young July and Aug.	27	15	19	22[10]	26	7	0	0	0	4	7	0
September	30	13	27	0	33[11]	7	7	0	0	0	16	0
October	48	10	40	0	17	33[12]	0	0	0	0	0	0

~ May-June before nesting, fresh snowfall; #May-June before nesting, no fresh snowfall; ^At summit cairns, huts, paths, and lochan rim beside a path; *Includes a few at boulder bivouacs; @Adults which had young, but here were eating for themselves.

Picnic scraps on several habitat types - snow edge, boulder-field edge, and reseeded patch - each comprised, in area occupied, <<1% of the study area. Snow comprised <3% of the area when use of this habitat type was tested. The biggest proportion in each row was tested, except in rows 3, 4, 10 and 12 where this was impossible because of too variable snow cover, and hence too variable areas of the most-used habitat types. Each superscript numeral refers to analysis by cumulative Poisson probabilities of obtaining the observed value or a more extreme one, $P < 0.00001$. Comparison of [7] vs [8] is by Fisher exact test, $P < 0.001$.

Parents gathered invertebrates on snow, flushes and other habitats (Table 1). Nearly all habitats used had many boulders. Smooth ground with few or no boulders and with continuous vegetation covered 41% of A when it was snow free, and >30% of it on 1 July each year, when much of A was under snow. However, I saw no bird with a nest or fledglings on smooth ground, and none foraging on it except at edges within 10m of a boulder patch. The most marked absences were on big tracts of grassland (eg in the centre of basins at Coire Raibeirt and at Cairn Lochan's Feith Buidhe, where the nearest boulder patches were >200m away).

However there can be too many boulders where they formed the entire surface, with no ground vegetation. Boulder fields occupied 41% of A in snow free conditions, and >50% of snow free land on 1 July, but I saw no birds with nests or fledglings foraging there except near the edge. Most adults with nests and fledglings foraged on intermediate ground with many boulders (18% of A when snow free).

Adults foraged much on snow patches (Table I). For example, in 90 minutes a cock with fledglings that could fly up to 30m after him made 18 trips on to snow, 4 to beside snow, 3 to a flush, and one to a boulder-field edge. However, during the nesting and fledgling periods I saw none foraging in the middle of snowfields >50m from boulders.

Snow free land had a brief insect peak. Snowbeds delayed its start and prolonged its duration. Land beside snow was frozen or waterlogged, but in a few days dried and warmed, leading to cranefly emergence. More snow had melted by then, so emergence lasted for weeks if the snow lasted. Foragers exploited this. Ground beside snow was much used by adults eating for themselves, cocks feeding brooding hens, cocks and hens feeding nestlings and fledglings, and fledglings feeding themselves. For example, on 8 August 1979 a hen and 2 fledglings 3-4 days out of the nest were beside a snowbed. She spent all of a 30-minute watch gathering food in a band 0.5-2 m out from the snow, mostly craneflies on moist soil. The chicks often followed her for up to 100m, which saved her time, but found food for themselves when temporarily on their own.

A day or two after nest departure, parents and young occasionally stayed within 200m of the nest, but often moved to a new place up to 1km away, where craneflies were relatively abundant. Even though nest sites lay near snow patches, frequently the snow there had gone by the time of nest departure, whereas the new places were beside big snow patches or in hollows that had held snow within a week. Interesting exceptions were in 1996 and 1997 on Cairn Gorm summit dome; adults took several broods up to 500m to bouldery grassland far from snow but near spots with picnic scraps which they ate and often fed to young. Parents gathered most food near the young, but sometimes afar, eg a cock flew 600m thrice in succession for craneflies, and a pair gathered insects beside snow and together flew >1km to day-old fledglings. M Marquiss (*pers comm*) watched a cock gather a beakful of insects and fly >l.5km, but the stage of breeding was unknown.

Adults and dependent young in a flock

Once chicks were getting most food for themselves, they followed parents, and adults stopped making foraging trips out of sight of the young. In 1977, a year of late first nests and no seconds (Watson 1996), 3 families flocked together. On 29 July, 2 cocks and 3 hens had broods 9, 10 and 15 days out of the

nest, in a loose flock though each hen and brood formed a unit. They fed in a 4-ha area and then in only 0.1 ha of bouldery grass, before flying in gloomy light at 2030 into a boulder field to rest. On 31 July the hens and young were in a 1-ha area about 300m away, again in a loose flock but acting as 3 units, and hens still fed both the later broods.

Adults and independent young in late July and August

All sightings in this period were on A, mainly on flushes in bouldery hollows. Some flushes issued temporarily from snow, but most were permanent, including rock-controlled ones, some of which were on low wet corries not seen to be used for nesting. A few sightings were of single adult cocks eating scraps at summit cairns, and insects and seeds. Adults and independent young, singly and in groups, foraged on snow more than breeders. On 23 and 26 August 1978 I saw 2 cocks, 3 hens and 5 juveniles from 2 broods run up steep snow in line abreast c1m apart, eating insects, and on reaching the top of the 60m wide snowfield fly down to start again, and repeat the sequence often. I watched independent young eating moss capsules and grass seeds as well as insects.

September

Though I saw some moulting adults at the end of August, the main annual moult occurred in September, as judged by the appearance of the plumage (Watson 1957). All sightings were on A. Reluctant to fly, most birds flushed within 5m, sometimes almost at my feet, and flew <15m to vanish among boulders, but sometimes an adult passed overhead, flying well.

Most were single (Table 2). In most cases, singletons were in bouldery hollows 1-3m wide, with a small flush. I saw none in flushes >5m from boulders, except for birds in flocks. About a fifth of sightings were in flushes below clifftops, and a few beside snow. Birds fed mainly on insects and seeds. Some singletons and small groups frequented summit cairns and tors visited by many walkers, eating mainly scraps with some insects. This habit already occurred in 1946 with a cock at Ben Macdui cairn, and in 1956 a cock and hen on Cairn Lochan.

October

After the moult, many were flying when first seen or heard. As in September, singletons were reluctant to fly, but they skulk in winter too, so skulking is inverse to group size, irrespective of moulting. However, they tended to flush at greater range than in September, and flew further (>20 m and usually >50 m). Most birds were in flocks, with singletons less frequent than in September (Table 2). I saw none on smooth grassland or heath. As well as using A, birds used B much.

The main foods were seeds of grass, sedge, rush and other herbs, with moss capsules. Occasionally birds ate insects, eg flies emerging on thawing new snow. Some ate picnic scraps at cairns, tors, footpaths, and the cafe on B. Ungerminated seeds of reseeded grass abounded after reseeding, eg all of a cumulative total of 64 birds seen on Cairn Gorm in October 1996 were on patches reseeded in late July 1996, and birds were seen to eat ungerminated seeds exclusively.

Discussion

Adult presence and absence on the main habitat types

Most breeding adults were on intermediate land with boulder patches near poorly drained

Table 2 ***Percentages of sightings of different group sizes in autumn 1966-97.***

Number in group	September	October
1	47	10
2	13	6
3	10	6
4	7	8
5	3	15
6	3	13
7	3	10
8	3	6
9	3	2
10	0	2
11	3	2
12	3	4
16	0	2
17	0	2
20	0	2
21	0	2
28	0	2
30	0	2
33	0	2
n	30	48

An analysis comparing proportions of singletons and all other group sizes combined, in September vs October, gave chi^2 = 11 (Yates correction), df = 1, P < 0.001.

or freely drained plant communities or snowbeds, and at boulder field edges beside such land. None was seen on continuous grassland or heath with few or no boulders or cliffs, or on Three-leaved Rush *Juncus trifidus* with grit patches and scattered boulders. In Baffin Island, Watson (1957, 1963) found up to a cock per ha in wet or dry spots where boulder cavities offered nest-sites, but few or none where boulders were smooth, or isolated (ie with cavities, but lacking nearby boulders as cover). Most boulders among Three-leaved Rush on A were tabular and embedded in soil, and so lacked holes, but interlocking boulders provided many holes.

Foraging on and near snow patches, and insect abundance

Many adults foraged on snow patches while breeding and shortly after. This supports ideas on snow as an important insect trap for insect-eaters (Mani 1962; Swan 1963; Nethersole-Thompson 1966; Pattie & Verbeek 1966; Watson 1966). Hendricks (1987) did not find this for insectivorous birds, but Antor (1995) did for high-alpine ones.

In some years I saw no foraging buntings on snow patches during the nesting and fledgling periods. As judged by visual impressions, craneflies abounded in 1969, 1971, 1972, 1973, 1975, 1977, 1979 and 1981 but not in 1968, 1970, 1974, 1976, 1978, 1996 and 1997 (I did not note this before 1968 and in 1982-95). In the first set of years I saw no foraging on snow patches in June and early July, when birds foraged mostly on grassland and flushes with abundant craneflies, but did see foraging on snow in late July and August, when visual impressions indicated few craneflies on the grassland and flushes used earlier. By contrast, in June and early July in the second set of years I saw more birds foraging on snow than on any other habitat except beside snow, which was favoured in every year.

A sole adult foraging on snow may be at more risk from predation, and so may feed there only if insects are scarce off the snow and there are no other accessible foods such as picnic scraps. I saw no dependent fledglings on snow, and no adults or others on snow in September during the moult. Avoidance of

predation might explain this. However, I saw very few insects on snow in September, and the area of snow left then was minute.

I observed far more foraging beside snow than on it. The role of frozen soil in delaying insect emergence and providing bird food for a longer period is not well recognised and deserves study.

Craneflies were fewer in late July and August than earlier, even in peak years. Often the only ones seen in late summer were on patches where foraging Snow Buntings and other passerines had concentrated. Adults feeding picnic scraps to nestlings and fledglings (as noted above) were seen only in late July and early August 1996 and 1997 on Cairn Gorm, a period and area with few craneflies as judged by visual impressions.

Movements during the breeding season

Above, I noted long flights by foraging adults, and movements with fledglings to new sites far from nests. Such movements might increase predation and may indicate poorer habitat. In a high density area in Baffin Island (Watson 1957,1963), I saw no such movements till young were independent

The birds' land use and protection measures

Moutling birds were reluctant to fly and may be vulnerable to predators. R. Smith (in Gibbons *et al* 1993) noted that adults become very unobtrusive during the moult in August and September, and 'a major loss of adults appears to occur at this vulnerable time'. Reseeded patches on the ski area and picnic scraps provide food near boulder cover then, and people there may keep predators away.

I had too few data from before the 1960 ski development to test for differences since. My impression was that birds used B more since 1960, associated with reseeded patches, the cafe, and more scraps due to more people. Nevertheless, in May and early June snowfalls before nesting, I saw birds on B and on Derry Cairngorm in many pre development years in 1943-59. Hence their use of these areas was not due to development, even though the frequency of such use currently may be.

Sites for protection should include all breeding grounds (area A), but also B, which birds use in autumn and in snowfalls before nesting. Existing and proposed Sites of Special Scientific Interest omit land north east of Cairn Gorm and the ski area's upper parts north-west of Cairn Gorm, which form some of A and much of B. All of A and B should be considered for inclusion.

One of the rarer regular breeders in the UK, the Snow Bunting did not nest in other EEC countries when the Birds Directive was announced in 1979 (79/409/EEC). Yet it is not in the Directive's Annex I, though the far more abundant Peregrine *Falco peregrinus*, Capercaillie *Tetrao urogallus*, Golden Plover *Pluvialis apricaria*, Short-eared Owl *Asio flammeus* and others are. A proposed Cairngorms Special Protection Area for Annex I birds omits more of A and B than the SSSIs. The Snow Bunting should be considered for Annex I and the SPA amended accordingly.

Acknowledgements

I thank Miss J Watson for drawing the map, and Drs M Marquiss, R D Smith and D B A Thompson for comments.

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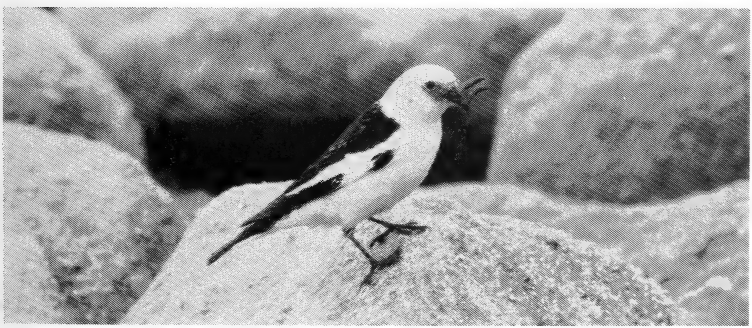

Male Snow Bunting *Alex Tewnion*

SHORT NOTES

Red-backed Shrike breeding records in Scotland

With reference to previous successful breeding records of Red-backed Shrikes in Scotland (*Scottish Birds* 18:118-119; 190), a pair of Red-backed Shrikes also bred successfully in Grampian in 1981, producing 4 young of which 3 survived.

R C Dickson, Lismore, New Luce, Newton Stewart DG8 0AJ

The note describing a successful breeding attempt in Perthshire in 1994 clearly did not summarise all previous breeding records. We do not intend to publish more such records unless they are part of a comprehensive review.

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Red-backed Shrike - summer records in Scotland

An adult male was at Glen Doll, Angus, during the summers of 1989 and presumably the same bird, in the same area, during 1990. It was seen by several observers, but no females nor any form of display, or territorial behaviour was noted. During the summers of 1988 and 1989, both sexes were regularly noted near Braemar. They appeared to be paired and to be defending territory in a fragmented Hawthorn hedge. No nest nor fledglings were seen by me. In 1981 an adult male lived at Muir of Dinnet from 17 May till last seen on 3 July. This was a year, when Wryneck *Jynx torquilla* was singing throughout June elsewhere in Deeside suggesting a Scandinavian origin. On 3 June 1994 an adult female was at Milton, north of Blairgowrie but could well have been a displaced migrant. Remains of a male were found at a Sparrowhawk plucking post near Lochmaben, Dumfriessshire on 19 June 1969. It may well have been a migrant too.

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Red-backed Shrike *Mike Ashley*

Ground nesting Treecreeper in Deeside

On 26 May 1996 I found an unusual Treecreeper *Certhia familiaris* nest at Dinnet Nature Reserve, Deeside. The nest was located in grass and Ling, *Calluna vulgaris*, at the base of a 15m Scots Pine *Pinus sylvestris*. The tree was in a mixed stand of Scots Pine and Birch *Betula spp.* The ground vegetation was approximately 0.15m tall and concealed a small grass lined cup placed almost directly on the ground. There were 2 live, naked young, one dead, naked young and one unhatched egg. By the 30th one of the young had died and, by 1 June 1996, the remaining chick was ready to fledge. On the 5th the chick had gone, presumably having fledged successfully. The nest contained the 2 dead chicks and the egg. The only previous record of ground nesting I have found refers to a nest in Derbyshire in May 1969. That nest too was at the base of a Scots Pine, though the ground vegetation was 0.3m high Bracken *Pteridium aquilinum* (Frost 1969, *British Birds* 62:446). The stand of trees in which the Dinnet nest was located was quite young, and probably lacking suitable nesting crevices, hence the unusual choice of nest site.

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Numbers of Snow Buntings on arable land in north east Scotland

Wintering Snow Buntings *Plectrophenax nivalis* in north east Scotland have been recorded mostly on hills and coastal dunes, but with some flocks in fields, mostly in Buchan and Clatt (S T Buckland, M V Bell & N Picozzi, 1990, *The Birds of North-East Scotland*). This understates their occasional high numbers and wide distribution in fields.

RR noted birds in 1984, 1986 and 1994-96 near Newburgh, and AW in 1988-96 in the course of studying Corn Buntings *Miliaria calandra* from Portsoy to Arbroath. Effort and locations searched were the same each year.

1983-84. January-February, big flocks in coastal fields in prolonged snow.

1985-86. January flocks of 600 at Collieston and 2,000 in uncut coats at Rashierieve.

1988-89. One at Towie in November, and 120 at Kinellar in December-January. In January, 225 at Inverurie, 108 at Corse, 84 at Crudie and 50, 80, 120 and 200 at 4 farms near Portsoy. At a fifth Portsoy farm 300 in January-20 February, 250 on 24 February, 30 on 26 February, 10 on 11 March, and none on 26 March. At Whitehills 1,100 in January, 700-800 till 26 February and none on 11 March.

1989-90. Two in 8cm of snow at Kennethmont in January.

1990-91. In January, 50 at Boyndie.

1991-92. In February, 8 in 6cm of snow at Badenscoth, and one in 5cm at Inverurie. In November-March, 100 in uncut oats at Gannochy moor near Edzell, not seen after the oats were burnt in early March, and none in 1988-91 when the field was rough pasture.

1992-93. In November, 2 at Garvock and one near Buckie. In November-January at Gannochy, 100 in uncut oats. One in 4cm of snow at Barras in February.

1993-94. In December, 70 in 4cm of snow at Crawton; deep snow further inland. In November-February, 15 in uncut oats on Gannochy moor.

1994-95. None seen. Wild geese devastated uncut Gannochy oats in October and Red Deer at the rest of the standing oats by 31 October.

1995-96. None seen. Red deer devastated uncut Gannochy oats in October.

Numbers seen in the winters of 1988-96, excluding repeated observations of the same flock, were 2,388, 2, 50, 109, 104, 85, 0 and 0, a big variation. Of the total of 2,739, 25% were 15-50km from the sea, 21% at 3-9km and 54% within 1km. Most were in north Banffshire and central or north Aberdeenshire, few in Kincardineshire, and none on study areas on and near the Angus coast. A few in 1989-94 were in fields with thin snow when higher land had deep snow; these birds vanished with the thaw.

To assess foraging we used cases where flying flocks were first seen to alight, to avoid bias due to birds being more easily seen on some fields such as short grass than on others such as stubble. Totals included some flocks observed more than once. Out of 8,286 cases, 49% were on wheat stubble, 26% on barley stubble, 13% and 4% on recently ploughed wheat and barley stubble, 4% on pasture, 3% in standing oats, 1% on a football pitch, 30 birds in rough grass by a farm road, and 2 each in uncut wheat, weedy set aside, and rough grass with herbs. As more stubble fields became ploughed, some foraged on newly or recently ploughed stubble in late February and early March, where grain was conspicuous on the dark earth. Birds husked oats and barley, but not wheat, which lacked husks. A few ate flies and other insects.

Snow Buntings disturbed by a raptor or person flew to low electricity wires, and sometimes to telephone wires and fences. They often flew to wires to loaf, and a flock was seen twice in a 10m Beech *Fagus sylvatica* tree, loafing on branch tips. One flock of 300 weighed down electricity wires. Obvious cocks in flocks varied from 0% to 10%, averaging 5.1% out of 1,848 in different flocks checked.

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Capercaillie and Black Grouse south of Banff in the 1940s

A map in Catt *et al* (1994, *Abundance and Distribution of Capercaillie in Scotland, 1992-94*, Institute of Terrestrial Ecology, Banchory) showed, incorrectly, that Capercaillie *Tetrao urogallus* had 'never been present' between Banff and Fyvie. Though their references list Pennie (1950, *Scottish Naturalist* 62:65-87), they did not use his good account for the area. Here I add my sightings of Capercaillie and Black Grouse *Tetrao tetrix* made in 1943-48, and information from others. All woods had mature/old Scots Pine *Pinus sylvestris* with some Birch *Betula sp* and Rowan *Sorbus aucuparia*.

Capercaillie

1. Forglen, 250 ha. Each year I saw a cock and hen in 4 ha of heather and blaeberry with self sown Norway Spruce *Pinus abies* and Birch. They bred in big tracts of self sown Birch and Pine with Blaeberry *Vaccinium myrtillus* and Heather *Calluna vulgaris*, and in planted pine, Norway Spruce and Larch *Larix decidua*. Up to 25 were seen in a winter pack; not seen after clear-felling and planting.

2. Delgaty, 160 ha. Capercaillie bred in old pine with Birch, Heather and Blaeberry, and in mature planted pine, with up to 20 in a winter pack. I saw a hen eat Beech leaves in May. Birds not seen after clear felling and Forestry Commission (FC) planting.

3. Lescraigie. A hen was seen in May in 30 ha of pine and Norway Spruce, later clear felled.

4. Lendrum, 55 ha. One to two seen each spring in Heather with pine and Norway Spruce.

5. Den of Woodhead, Balquhollie, 20 ha. One to 2 seen each spring in scattered pine and Norway Spruce with grass, Blaeberry and nearby Beeches.

6. Brownside, Mountblairy, 95 ha. This was cut by 1943, but the gamekeeper said it held many Capercaillie before cutting; not seen after FC planting.

7. Montcoffer, 120 ha. Capercaillie bred in old pine with Heather and Blaeberry, and nearby Beeches. Up to 16 were seen in a winter pack; not seen after clear felling and planting.

8. Den of Rothie. Pennie gave useful information on breeding numbers here, calling it 'Den Wood', and estimated that there were 500 acres of suitable habitat. Mr Main, Fyvie Castle gamekeeper, told me in March 1949 that 'they shoot 8-9 every year and usually see 20-30 in a day's drive. Occasional wanderers move into other wood on Fyvie (Cranna, Brownhill, Cockhill and Fyvie Castle). I haven't noticed any difference in numbers over the years' (he had been there for 37 years).

9. Hatton Castle. The owner Lt Col Duff told me in March 1949 that he shot a Capercaillie at Hatton about 1934, and 'at one time I saw them fairly often and there were a nest or 2 at the east end of the Den of Balquholly, but those trees are now cut down. I saw one hen in the Wood of Colp 2 years ago, but I think any Caper at Hatton now are merely visitors'. Den of Balqhuolly is near Lescraigie (3 above). It had semi open patches with some Heather and Blaeberry. The Wood of Colp was of old planted pine and Norway Spruce, with grass below.

Black Grouse

1. Forglen. Black Grouse bred each year. Up to 6 were seen in a winter pack; not seen after felling.

2. Delgaty. Birds bred each year with up to 12 in a winter pack; not seen after felling.

3. Waggle Hill, 175 ha of sedgy and rushy Heather. Breeding ocurred each year with up to 10 in a winter pack; not seen after FC planted nearly all of it.

4. Greenness Hill, 30 ha of sedgy and rushy Heather. One to 2 hens bred each year, only 1 km from nearest part of Waggle Hill; not seen after FC planted all of it.

5. Fyvie Castle and Den of Rothie. The laird (Forbes-Leith) told me there used to be 'quite a number', in both these places, the last in 1912 as planted woods thickened. Gamekeeper Mr Main confirmed this in 1949, adding that they had bred annually and he shot the last one in 1912. They were regularly on Minnonie and other Ythan braes to Gight Castle and east of it. Later the FC planted conifers densely on big parts of the braes.

6. Hatton Castle. Lt Col Duff told me in 1949 that they nested annually in the middle and north ends of the Den of Balqhuolly.

Delgaty, Montcoffer and parts of Hatton and Den of Rothie resembled Caledonian pinewood and much of Forglen was developing into natural boreal woodland. Their destruction was tragic. Felling, burning and dense planting of mostly exotic conifers eliminated heath, save in narrow rides. This ended thriving stocks of both species, decades before recent concerns over their decline and years before Foxes *Vulpes vulpes* colonised the area in the late 1950s.

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Black Grouse *Brent Hurley*

Reed Warblers breeding in south west Scotland

In Scotland the Reed Warbler *Acrocephalus scirpaceus* occurs regularly in spring and autumn with only one breeding record in Shetland in 1973 (Thom V M 1986. *Birds in Scotland*). In England and Wales the overall breeding population is estimated between 40,000-80,000 pairs (BTO/JNCC: *Britain's Birds in 1990-91).*

On 17 September 1992, members of the North Solway Ringing Group were mist netting in a Galloway reedbed when a juvenile Reed Warbler was trapped and ringed (Table 1). It could not be ascertained whether the bird was locally bred or was a migrant. This was the first Reed Warbler caught by the Group.

On 3 visits to the reedbed during August 1994, 6 adult birds, 3 being female with well formed brood patches, were caught. Two of the adult birds had been ringed at the site in 1993 (Table 2). Three juvenile birds, all strong fliers, were also trapped and marked. Singing males had been heard in the reedbed every month between May and August.

During July and August 1995, 18 Reed Warblers were caught at the site. Eight were juveniles with either remiges or rectrices still growing with large parts of the body still bare. Also trapped were 9 adults; 4 females, 5 males, with 3 of the birds having been ringed at the site in previous years. One of these birds had been ringed as a recently fledged juvenile on 5 September 1993. An adult bird was also seen in attendance with 2 newly fledged young.

Table 1 ***Annual totals of Reed Warblers caught in a Galloway reed bed 1992-96.***

	1992	1993	1994	1995	1996
Juveniles	1	2	3	9	20
Adult (new)	-	4	4	6	3
Adult (retrap)	-	-	2	3	6
Totals	1	6	9	18	29

In 1993 visits were made to the same reedbed on several occasions when at least 2 singing males were holding territory. By the end of the summer mist netting had produced 4 adult birds, one of which was a female with a well developed brood patch. On 5 September, 2 juvenile birds were caught. The birds, recently fledged, had traces of down, weak and loose body feathers with bare skin under the wings still quite discernible and they were barely able to fly.

During 1996, while only 5 males were caught, it is believed that 7 singing males were in the reedbed. Juvenile fledging was up on previous years with 20 birds trapped (Table 1).

This would appear to be a notable range extension of the species into mainland Scotland. The nearest known breeding Reed Warblers are in Cumbria where 2, possibly 3 pairs, bred in 1993 *(Birds in Cumbria:* County Natural History Report 1993). In *The Atlas of*

Table 2 ***Reed Warblers returning to reed bed in subsequent years.***

Ringing year and No. of birds ringed		Year of retrap 1992	1993	1994	1995	1996
1992	1	-	-	-	-	-
1993	6	-	-	2	2	1
1994	7	-	-	-	1	3
1995	15	-	-	-	-	2
1996	23	-	-	-	-	-

Breeding Birds in Britain and Ireland (Sharrock 1976) there were no breeding dots for Cumbria between 1968-72 while *The New Atlas of Breeding Birds in Britain and Ireland: 1988-1991* (Gibbons, Reid and Chapman 1993), gives 7 full dots. This obvious range expansion northwards can also be seen on the east coast of England, in North Yorkshire and Durham, where in the same 20 year period between the *Atlases* 4 dots compared to one dot is shown.

During the summer of 1996 a second breeding site in south west Scotland was found at Caerlaverock National Nature Reserve.

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I am grateful to Dr Malcolm Ogilvie for helpful comments on an earlier draft.

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Mallaig, Wellington Street,
Glencaple, Dumfries.

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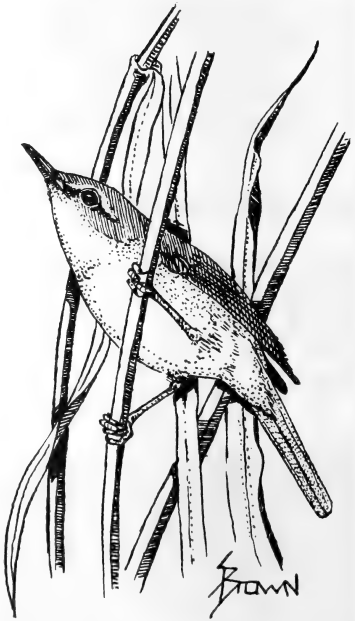

Reed Warbler *Steven Brown*

Inland nesting by Razorbills

Razorbills *Alca torda* breed solitarily or colonially in rocky coastal areas, on mainland cliffs and offshore islands. The breeding site is usually in a boulder scree or on a small ledge or niche, on a rocky clifface. Less commonly, birds nest in earthy burrows or on the nests of Kittiwakes *Rissa tridactyla.* As the chick leaves the nest site when only partly grown and still unable to fly, most colonies tend to be directly above the sea. Although there are published records of breeding sites up to 300 m inland in Greenland (Salomonsen 1950, *Grønlands Vogel),* to our knowledge similar cases have not previously been described in Britain.

During the last few decades, the numbers of several species of cliff nesting seabird, including Razorbills, have increased substantially on the Isle of May in the Firth of Forth, a trend which is in line with many other colonies around the North Sea (Lloyd *et al,* 1991, *Status of Seabirds in Britain and Ireland).* A notable feature of the increase on the Isle of May has been that several species have 'spilled over' from the seacliffs to breed up to 100 m inland on low cliffs and steep vegetated slopes. The main area of overspill has been around a manmade freshwater loch, which is about 20m above sea level and separated from the sea by a dam, a 50 m slope of eroded

The loch on the Isle of May. The main group of nesting Razorbills on the south side was in the Kittiwake colony in the top left corner of the photograph. *Mike Harris*

soil and loose rock and a boulder beach (see photograph). By the early 1990s, the slopes and low cliffs either side of this loch had been colonised by Kittiwakes, Fulmars *Fulmarus glacialis* and Puffins *Fratercula arctica* but Razorbills had never been recorded in the area, although large numbers were breeding on the cliffs at the seaward end of the loch. Annual counts of a monitoring plot on the seacliffs just north west of the loch showed that the number of Razorbills present increased by 6-7% per annum between 1983 and 1995. It was also apparent that, each year, birds were progressively colonising the cliffs above the boulder beach and the eroded slope, and were moving towards the dam.

In 1994, Razorbills were occasionally seen flying over the loch and we assumed that these birds were taking a short-cut to the east side of the island. However, in June 1995, birds were observed standing on, and among, Kittiwake nests on both sides of the loch. One pair of Razorbills on the north side definitely had an egg on 15 June, but it is not known if they fledged a chick (Harding & Thompson, 1996, *Studies of breeding birds on the Isle of May in 1995,* SNH Report). On the south side of the loch, a pair with a recently-hatched chick was recorded on the late date of 14 July. The chick was still present on 25 July, but again, the breeding outcome was unknown. In 1996, a pair bred at the same site on the north side of the loch and their chick left on 23 July. Up to 12 individuals were recorded on the south side; four or five pairs laid, and at least three of these reared a chick to leaving age.

Although Razorbills appeared to have no difficulty rearing chicks at these inland sites, they faced a potential problem at fledging. Under normal circumstances, the chick jumps from the nest-site at dusk, and glides, or plummets, to the sea, accompanied by its male parent. All being well, the adult and young meet up on the water and immediately swim out to sea together. It is impossible for Razorbill chicks from the lochside to reach the sea directly and it is almost inevitable that they will land on the loch. On the morning of 20 July 1996, there was an adult and a chick on the loch, but within an hour both had disappeared. To have reached the sea, the chick would have had to climb around the dam, and walk about 50 m through several Herring Gull *Larus argentatus* territories, a fairly perilous procedure.

It will be interesting to see whether further colonisation of this inland habitat occurs and if there is any evidence of successful fledging.

M P Harris & S Wanless,
Institute of Terrestrial Ecology, Banchory AB31 4BY

Accepted December 1996

Hooded Warbler on St Kilda

At midday on 10 September 1992 J Vaughan and myself were at the army base at Village Bay on Hirta, JV saw a bird that 'looked like a large *phyllosc* but with black on its head' fly past him and disappear over the sea wall on to the beach. Together we almost immediately relocated the bird. The heavy rain and strong gusts of wind made viewing condition difficult. My first impressions were of an almost wagtail like passerine, basically olive green above and yellow below but with black on its crown, extending back to the nape and around the sides of its head to behind the ear coverts and with a black gorget. The legs were bright pink and robust.

The bird frequently cocked up or flicked its tail. It was very lively and would not permit a closer approach than 10m. The flight was fast and low, on shortish wings which served to exaggerate the length of the tail. We continued to watch it for some 4-5 minutes making mental notes as the poor weather made writing impossible. We adjourned to the Factor's House to check reference books. Identification was straight forward. The large size, robust features and general colouration combined to eliminate all but 2 species: Hooded and Wilson's Warblers. The latter was immediately eliminated due to our bird's distinctive head pattern. We went out again and, after a short search, relocated the bird in the same area. The diagnostic presence of white patches on the 3 outer feathers of the upper tail was eventually confirmed, though this feature was only apparent when the bird flicked open its tail or hovered. The bird was watched for a further 2-3 minutes before we agreed not to push it around any further in the appalling weather.

The bird was seen briefly later in the afternnon by JV, perched on a wire outside the army base. That night, continuous heavy rainfall was severe enough to cause flooding in the Village Bay area. The bird was never seen again.

A series of fairly active Atlantic depressions had crossed the area during the preceding few days and a depression was centred over sea area Hebrides at the time of the discovery. A vigorous westerly jetstream had apparently become established at upper altitudes several days before(I Robinson, Benbecula Met Office) which would have assisted trans Atlantic vagrancy.

There has been one other occurrence of this species in Britain and Europe, a female from 20-23 September 1970 on St Agnes in the Scilly Isles.

T J Dix, 2 Drimsdale, South Uist PA81 5RT

Accepted December 1996

A full description is in the files of the British Birds Rarities Committee. This is the first Scottish record. Although it has been customary for such records to be published in Scottish Birds that practice originated when Scottish Birds was the SOC's only publication. In future such records will be published in the Scottish Bird Report.

Scavenging Merlins

I read with interest the note (Thomas 1992, *Scottish Birds* 16:219-220) on a Merlin *Falco columbarius* feeding on Rabbit carrion in Tayside. Scavenging by Merlins has rarely been seen or reported. During intensive observations of Merlins between 1965-96, I have only recorded one apparent attempt at scavenging by wintering Merlins in over 800 observations.

On 25 August 1977 at 1650hrs, in a sandy bay on the coast over a kilometre from a Merlin's roost in Galloway, a female or juvenile Merlin was watched standing on and apparently pecking at a juvenile Greater Black-backed Gull *Larus marina*. The Merlin was soon displaced by a Carrion Crow *Corvus corone*. It landed a short distance away. Ten minutes later the Merlin chased a passing flock of Ringed Plovers *Charadrius hiaticula* enough to indicate that it was healthy and uninjured. The Merlin flew on out of sight. On inspecting the dead gull, the feathers were found to be intact and the skin unbroken. I cannot say whether the Merlin was attempting to feed on the gull or using the carcase as a hunting perch, pecking at it inquisitively.

Apart from the reference given in Thomas's note I know of 2 others on scavenging by Merlins. Warkentin (1986 *Canadian Journal of Zoology* 64:262-264) recorded a radio tagged Merlin released 51 days after being found injured that was killed by a vehicle when feeding on a feral pigeon *Columba livia* killed on a road. Warkentin & Oliphant (1988, *Wilson Bulletin* 100:137-139) recorded a radio tagged female Merlin apparently scavenging a feral pigeon frozen to a roof top. Although other species of raptors like Peregrine *Falco peregrinus* and Sparrowhawk *Accipiter nisus* have been illegally killed in Britain while scavenging at poisoned baits, Merlins have not (D Dick *in litt*).

R C Dickson, Lismore, New Luce, Newton Stewart, Wigtownshire DG8 0AJ

Accepted December 1996

Buzzard robbing juvenile Peregrine of prey

Peregrine *Falco peregrinus* occasionally steal from other raptors (Ratcliffe 1993, *The Peregrine Falcon*, London) but records of Buzzards *Buteo buteo* stealing from Peregrines are generally lacking in Britian. On 3 September 1995 a juvenile Peregrine was standing on a dead, adult Black-headed Gull *Larus ridibundus* in a shallow muddy pool on flooded pasture near Stranraer, Galloway. As the falcon tried to lift its prey out of the mud it began to call as a Buzzard landed on a fence post 10-15m away. The falcon managed to free the carcase and, as it landed, it was immediately displaced by the Buzzard. The Peregrine flew up calling and swooped on the Buzzard 3 times, before landing 2-3m away. The Buzzard pecked at the carcase and once approached the

Peregrine on foot in a threatening posture. Nine minutes later the Buzzard flew back to the fence post while the Peregrine flew to the carcase and fed on the gull for the next 25 minutes.

The Buzzard only made a half hearted attempt to eat the gull but was possibly intimidated by the presence of the Peregrine. In North America, Peregrines usually yield their prey to *Buteos* (Beebe 1960, *Condor* 62:145-189) In this case the Peregrine regained possession of its prey without too much effort, from, I suspect, an inexperienced, juvenile Buzzard. Three Buzzards had been seen together on previous occasions in the same field, possibly juveniles from the same brood.

R C Dickson, Lismore, New Luce, Newton Stewart, Wigtownshire DG8 0AJ

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Interaction between Sparrowhawk and Jackdaw near Newtonmore, Highland

On 14 January, 1995 I was alerted to a disturbance by the agitated calling of a large number of corvids, close to my house, near Newtonmore, Highland. I saw a female Sparrowhawk *Accipiter nisus* and, as I later discovered, an adult Jackdaw *Corvus monedula* fighting on the ground. It was obvious that the confrontation may have turned into a lengthy one and I started the timer on my wristwatch. The ground was sloping and during the first few minutes of struggle, both birds tumbled a couple of metres downhill. The Sparrowhawk had one talon locked into the breast of its prey but the Jackdaw was resisting fiercely, flapping its wings, jumping up to 30cm into the air and stabbing with gaped beak as they tumbled. The Sparrowhawk arrested its fall with its free talon by grasping at the bank; the other remained locked firmly into the flailing Jackdaw. The mixed corvid flock of about 40 Jackdaws and Rooks *Coruvs frugilegus* continued to call from the surrounding trees. Several individuals swooped to branches just a few metres above the Sparrowhawk but none alighted on the ground or attempted to make physical contact.

During the next tumble down the slope, the Sparrowhawk locked its other talon into the Jackdaw. The birds came to rest on a small level area, the hawk on its back, with the Jackdaw held by extended legs. Both birds rested for between 2 and 3 minutes. Following another short tumble, the Sparrowhawk gained the upper position using its outstretched wings to balance and mantle its prey. Only at this stage did it seem to assess its surroundings, glancing around at the corvid flock, which caused them to increase the intensity of their calling.

The struggle continued for 9 minutes and the Jackdaw made repeated attempts to escape. After 11 minutes the Jackdaw's resistance had lessened and the corvid flock dispersed. One or 2 individuals settled in isolated trees about 200m away.

After 23 minutes, the Sparrowhawk attempted to pluck the Jackdaw which responded by weakly flapping its wings. After 29 minutes the Sparrowhawk plucked at feathers and began to rear at the Jackdaw's flesh and no more movement was seen from the prey.

Between the 39th and 43rd minute of the observation, the Sparrowhawk made 3 unsuccessful attempts to move the carcass. After resting for 7 minutes it resumed feeding for the next 2hours 15minutes. As it fed, the corvid flock reappeared landing in nearby trees, flying around and calling excitedly. After a minutes or so, they dispersed once again as quickly as they had arrived. Again, 2 individuals settled in isolated trees, in sight of the Sparrowhawk. Three hours and five minutes after first taking the Jackdaw to ground, the Sparrowhawk moved approximately 1m from the carcass and preened. The movement elicited a response from a single Rook which flew back to a tree above the Sparrowhawk and called intermittently. The Sparrowhawk left the area after 3 hours 20 minutes and was not seen to return, though the carcass disappeared within 16 hours.

Jackdaws have been recorded before as Sparrowhawk prey items (Newton, *The Sparrowhawk*, Poyser 1986) as has the fact that large prey may not be killed immediately, but may die later during plucking and eating (Cramp & Simmons *Birds of the Western Palearctic*, Vol 2, October, 1980). This observation highlights the potential hazards to a predator which has preyed on a relatively large and social species. The rewards must be set against the energy required to subdue the prey and the risk of potential injury.

I thank Steve Redpath for his thoughts on this observation.

P R Moore, Scottish Natural Heritage, Achantoul, Aviemore, Inverness-shire PH22 1QD

Revised manuscript accepted January 1997

Sparrowhawk attacking a Jackdaw *Mike Ashley*

Mobbing of Waxwing by Chaffinches and Blue Tits

The short note in *Scottish Birds* 18:250 coincided with a very similar experience we noted on 10 December 1996 on a gloomy, damp morning about 0900hrs, when from our bedroom window we saw a single Waxwing, *Bombycilla garrulus*, eating the berries of a Rowan *Sorbus vilmorinii*. We noted that the other birds in the same tree comprising Blue Tits *Parus caeruleus*, Chaffinches *Fringilla coelebs*, and Greenfinches *Carduelis chloris* were acting in a very agitated manner. Our fears that this was due to a predator in the form of a domestic cat proved groundless. It seems possible that it is the solitary Waxwing, rather than a flock, which arouses the hostility of other birds. On 18 December 1996 16 Waxwings held sway over the berries of the Rowan both in the tree and on the ground. We were not aware of any antagonistic behaviour from other birds.

S & M E Shimeld, 1 Rtichie Place, Crieff PH7 3SL

Accepted January 1997

Waxwings feeding on Cowberries

British birdwatchers tend to associate Waxwings with urban parks and gardens, where they are most often seen feeding on the berries of small trees or tall shrubs notably Hawthorn *Crataegus* Rowan *Sorbus* and *Cotoneaster*. On 28 January 1996, I saw 8 Waxwings *Bombycilla garrulus* feeding on the ground on the berries of Cowberry *Vaccinium vitis-idaea* on heather moorland a few miles north of Blair Atholl at 360 metres above sea level.

Joan Howie has told me that she used to see Waxwings feeding on Cowberry in Strathspey when she lived there.

Birds of the Western Palearctic (vol V pp494-496) records Waxwings feeding on berries of *Vaccinium* though the records are mainly from breeding areas.

This behaviour may be under recorded in Britain since birdwatchers are most likely to see Waxwings in or near towns.

Ron Youngman, 20 East Moulin Road, Pitlochry PH16 5HY

Revised manuscript accepted January 1997

Advice to contributors

Authors should bear in mind that only a small proportion of the *Scottish Birds* readership are scientists, and should aim to present their material concisely, interestingly and clearly. Unfamiliar technical terms and symbols should be avoided wherever possible and, if deemed essential, should be explained. Supporting statistics should be kept to a minimum. All papers and short notes are accepted on the understanding that they have not been offered for publication elsewhere and that they will be subject to editing. Papers will be acknowledged on receipt and will be reviewed by at least 2 members of the editorial panel and, in some cases, by an independent referee. They will normally be published in order of acceptance of fully revised manuscripts. The editor will be happy to advise authors on the preparation of papers.

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Tables, maps and diagrams should be designed to fit either a single column or the full page width. Tables should be self explanatory and headings should be kept as simple as possible, with footnotes used to provide extra details where necessary. Each table should be on a separate sheet. Maps and diagrams should be in Indian ink and be camera ready, but drawn so as to permit reduction to half their original size.

NEOTROPICAL BIRD CLUB

Neotropical bird club launched

A club has been launched to promote the study and conservation of the birds of the Neotropics (South America, Central America and the Caribbean). It is currently seeking founder members to help reach the launch budget of £2000, which is required to get the club running and to publish the two first issues of its intended journal 'Continga'. Founder members will be asked to pay a minimum of £25, and will be formally acknowledged in the first issue of 'Continga'. 'Continga' will provide a colourful and much needed forum for exchange of information on the avifauna of this extremely rich and diverse area, and will contain papers and features on the birds and their conservation as well as news of recent observations and discoveries (at present, new species are still being discovered at the rate of more than two a year). It is hoped that in due course the club will be able to provide direct funding and support for practical conservation programmes.

For further details and membership forms, please contact:
Rob Williams,
Publicity Officer,
Neotropical Bird Club,
c/o The Lodge,
Sandy,
Bedfordshire SG19 2DL

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Observations at a winter Rook and Jackdaw roost in Aberdeenshire

I S FRANCIS

A large corvid roost near Alford, Aberdeenshire was counted during winter 1994-95. Up to 18,500 birds used the roost from early September to late March, with peak counts in late November. Around 68% of the birds were Rooks, the remainder Jackdaws. The roost was utilised by birds from perhaps as far as 20 km distant. Arrival times and behaviour are described. The roost is important in a national context, and reflects the very high densities of Rooks in Aberdeenshire.

Introduction

Large winter roosts of Rooks *Corvus frugilegus* and other corvids, including Jackdaws *Corvus monedula,* have been described from numerous parts of Scotland, particularly during an SOC inquiry from 1969-1975 (Munro 1975), when 164 such roosts were noted. During the winter of 1994-95, I visited a mixed corvid roost from September to March, estimated numbers of roosting birds and made some observations of arrival times and behaviour.

Site description

Meiklemoss Wood, near Alford, Aberdeenshire (NJ 602161; 145 asl) is a mixed Scots Pine - Birch *(Pinus sylvestris - Betula* spp.) woodland of cl0 ha, on level ground with a thicker Birch fringe and a few scattered spruces *(Picea sitchensis & P abies).* Canopy height is around 10-14 m. The understory is mostly grassy and dominated by the grasses *Holcus mollis* and *Deschampsia caespitosa.* There are some open areas with Heather *Calluna vulgaris* and Broom *Cytisus scoparius.* Within the roost area there are some dead trees, possibly killed by the birds' droppings , beneath which lie dense patches of Chickweed *Stellaria media* with Nettles *Urtica dioica.* Feathers and pellets are scattered over an area of around 100 x 200 m, indicating the approximate extent of the roost. In general, the impact of a large number of roosting corvids on the woodland appears minimal, though the Chickweed and Nettle patches are clear evidence of a fertilising effect. The introduction of *Stellaria media* to a rookery has been recorded elsewhere (Rieley and Shah 1984), though Meiklemoss Wood is not a breeding rookery. This corvid roost appears to have arisen in the last 15 years or so (J Latham *pers comm*); in 1971, Munro (1975) could find no Rooks in Strathdon in winter, the nearest roost being 5 km to the south west at Muir of Fowlis.

Methods

The roost area was visited 21 times, around 7-9 days apart, initially by car but later viewed from one vantage point, and estimates made of numbers of birds entering the roost. On most occasions, it was necessary to estimate in 5-10 minutes large numbers of incoming

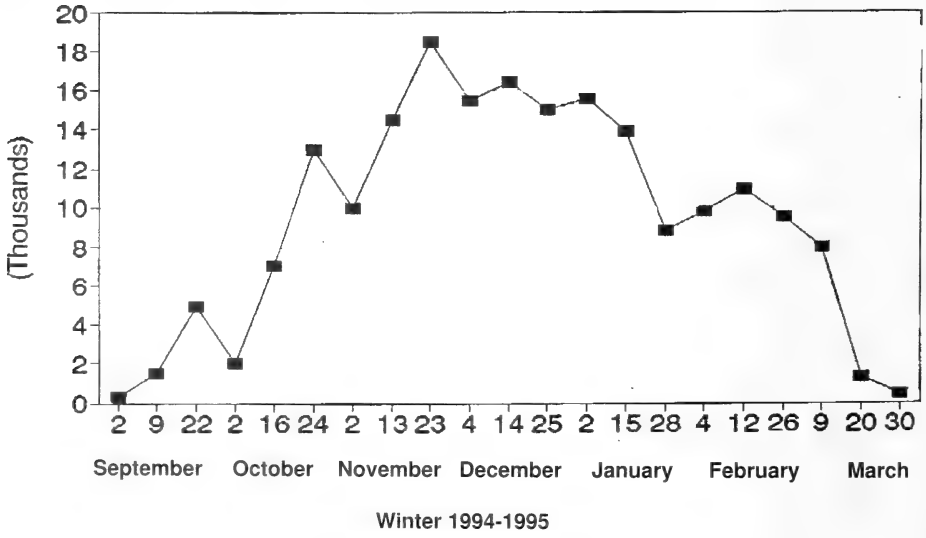
birds, which were counted in blocks of 50 or 100. This inevitably led to inaccuracies. In order to assess the extent of this on one occasion, 3 independent observers estimated numbers which varied from 8,000 to 9,500. This indicates the probable degree of error, but also shows that the numbers recorded were probably not more than 20% under or overestimated. The proportions of Rooks and Jackdaws were usually extremely difficult to determine under count conditions. Therefore, on 5 different dates, 30 counts of large pre roosting aggregations were made by 3 observers. Proportions of Jackdaws varied from 25% to 38%, with no apparent trend, but most lay in the range 28-36%. A figure of 32% Jackdaws was used in all flock counts to estimate numbers of that species. However, much of the account below relates to total corvids. Carrion Crows *Corvus corone* were noted only very rarely.

Results

Total numbers of birds and changes through the winter

The roost peaked at 18,500 on 23 November 1994, comprising around 13,900 Rooks and 4,600 Jackdaws. Rook numbers rose from around 300 in early September to over 5,000 by mid October. Numbers were over 10,000 from mid November to early January, dropping to 2,800 by mid March then very rapidly to under 300 by the end of March. There was no indication that the proportion of Jackdaws changed greatly through the winter, and the roost held over 3,000 from late October to mid January. Figure 1 illustrates the trend in numbers for total corvids. There was no significant roost before early September or after the end of March, though in late summer, at least one other area nearby (Breda Wood,

Figure 1 ***Combined numbers of Rooks and Jackdaws roosting at Meiklemoss Wood.***



5 km to the west) was used for roosting, prior to utilisation of Meiklemoss Wood.

Roosting times

On all occasions, arrival in the roost proper occurred shortly before almost total darkness and well after sunset. Weather conditions did not influence this. Arrival times in the roost proper, therefore, changed systematically, linked to time of darkness, through the winter, from 1930 GMT in early September to 1624 GMT in late December and 1938 GMT in late March. However, arrival in the pre roost gathering areas was much more variable, with the first birds usually arriving to feed in favoured fields up to 55 minutes before roosting, though 25-30 minutes was more usual.

Pattern of arrival and catchment area

Birds usually arrived in pulses of several hundred, presumably feeding flocks, separated by periods with few arrivals, from several consistently favoured directions, mostly to the south and west. They usually dropped into fields (both grass and stubble) to the south of the wood and the A944, where they fed and undertook occasional pre roost flights. Birds were observed flying to the roost from over 5 km to the west and over 10 km to the south west. Other observations of flightlines also suggested that the roost was holding birds which fed much further west up Strathdon, perhaps 20 km distant. However, most birds appeared to come from the Alford to Tarland area.

Behaviour

Birds arrived in pre roost flocks in nearby fields, sometimes in nearby small woods and trees, and most fed, though many spent time sitting quietly on fences. Periodically groups would fly up in short display flights in tight flocks, before settling again. The flights involved circling over the wood with sudden dives by tight flocks, followed by rising higher again. Sometimes these flights would extend over the roost wood, some 500 m distant, and arriving birds would often tumble and undertake short display flights before landing in the fields. Occasionally, birds would fly over and look at, or tumble into the roost woodland on arrival, then fly out again to join birds in the fields. On 2 occasions, shortly before the actual roosting flight began, the entire flock flew up over the roost wood and performed complex flights, before returning to the fields (once) or dropping into the roost. However, the usual behaviour immediately before roosting was for some small flocks to take off and carry out display flights over the wood. This then seemed to prompt the rest of the birds to fly to the wood in large waves, usually dropping in fairly quickly. Once birds landed in the roost it was rare for them to take off again.

Discussion

Communal roosting in Rooks and Jackdaws has often been described, though there have been few recent detailed accounts of individual roosts, particularly in Scotland. Early work by McWilliam (1924) and Munro (1948) was later succeeded by studies in the Ythan valley (Patterson *et al* 1971; Feare *et al* 1974), which concentrated on wider issues of Rook ecology, though Feare *et al* (1971) considered roosting behaviour in detail. North east Scotland seems notable for the number and size of corvid (particularly Rook) roosts. Munro (1975) described 11 known Rook roosts in Aberdeenshire and at least another 3 possible sites (see also Watson 1967; Dunnet and Patterson 1968). Estimated numbers of birds

ranged from 2,000 to 10,000 at several roosts, 21,500 at Ellon, 49,000 at Straloch and 65,000 at Hatton Castle, the largest known in Scotland. Roosts quite close to Meiklemoss Wood were Dunnideer Hill, Insch ('thousands') and Inver Fowlis (Muir of Fowlis, 7-10,000). At least 6 were known from Banffshire (numbering up to 30,000), one from Kincardineshire (5-10,000) and 3 from Morayshire (numbering up to 20,000). In all these estimates, Jackdaws were not counted separately. Earlier in the century, and elsewhere in Scotland, McWilliam (1924) considered Jackdaws were very much a minority in a roost of 12,000 corvids on Bute.

I also visited Meiklemoss Wood during the winter of 1995-96, on 3 December 1995, when 19,500 corvids were estimated, and during winter 1996-97, on 13 December 1996, when c13,000 corvids entered the roost. It was also counted in 1992, when a much larger figure of 37,000 Rooks was recorded (R J and S J Aspinall, NE Scotland Bird Report 1992); there were also up to 12,000 Jackdaws. Clearly, the roost can hold larger numbers than those recorded in 1994-96. However, using population and mortality figures given in Lack (1986) and Gibbons *et al* (1993), the Meiklemoss Wood roost may have held, in 1994-95, around 0.5% of Britain's winter population of Rooks. Rook breeding densities in Aberdeenshire are the highest recorded for Britain, with the largest rookeries (Dunnet and Patterson 1968; Thom 1986) and Feare *et al* (1974) considered this to be attributable to small scale field patterns, abundant winter stubble, late harvests and later spring sowings. These high densities are clearly reflected in winter, and make Aberdeenshire in general, and roosts such as Meiklemoss Wood in particular, of great significance for this species in national, and probably also European, terms.

Rooks will travel up to about 50km (30 miles) to communal roosts in the winter, with similar movements for Jackdaws (Holyoak 1971). The roosts are linked to the rookeries, even in winter, with birds flying from roost to rookery in the morning (Dunnet and Patterson 1968). In Aberdeenshire, maximum distances to roost in the Ythan valley were nearer 10-19 km (Patterson *et al* 1971). Buckland *et al* (1990) note that in the years prior to 1990, a large roost was present at Muir of Fowlis, which served upper Deeside and Donside. This roost is not now present, following felling of many trees at the site around 1989, and may have been replaced by Meiklemoss Wood, 5 km to the north east. Birds observed flying to roost at Meiklemoss Wood at up to 10 km away would accord with observations from elsewhere.

Feare *et al* (1974) found that for most of the year the times of entering and leaving the roost were related to sunrise and sunset, this relationship being affected to only a small extent by the weather. This was clearly so at Meiklemoss Wood. Munro (1948) and Feare *et al* (1974) also described pre roosting and roosting behaviour which was seen in this study too. The latter authors concluded that the main function of roosting lay in the post roost behaviour. Assembling after roost, and the dispersal from such assemblies, enables Rooks to locate food in unfamiliar surroundings when conditions prevent them from using their usual feeding grounds; each individual has access, through the flock, to a larger store of knowledge of potential food resources. The erratic display flights before roosting were considered to be anti predator behaviour.

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The diet and foraging behaviour of the Red Kite in northern Scotland

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Red Kites have recently been successfully reintroduced to northern Scotland to an area with a presumed rich food supply. This study showed that the diet was composed mainly of Rabbits, both in winter and summer. Other important components of the diet were voles and terrestrial invertebrates in winter, and birds, particularly Corvids, in summer. The kites also scavenged on sheep and deer carrion, household refuse and fish. Red Kites foraged over pasture, stubble, woods, the foreshore and village gardens. They employed different foraging techniques: pouncing from the air, hawking insects, scavenging and kleptoparasitism. The scavenging of Rabbits killed on the road makes the kites vulnerable to collisions with traffic, whilst feeding on shot Rabbits makes them susceptible to lead poisoning

Introduction

Ninety three juvenile Red Kites *Milvus milvus*, translocated as nestlings from Sweden, were released in northern Scotland between 1989 and 1993 as part of a scheme to reintroduce Red Kites to Scotland, after a period of extinction of about 100 years (McGrady *et al* 1994). Successful breeding was first recorded in 1992 and there has been a steady growth in the population subsequently, reflecting the success of the scheme (Evans *et al* in press). The release sites were selected in areas of lowland farmland and woodland similar to Sweden where there are sufficient feeding and nesting habitats. Now that a breeding population is becoming established, their use of the habitat can be assessed. This paper describes the diet and foraging behaviour of the Red Kites both in winter and summer.

Methods

Many of the Scottish kites roost communally in woodland throughout the winter and early spring. The main communal roost was visited during January to April 1994 and 10 fresh pellets were sub sampled from a large number collected each month. The pellets were broken up for examination and larger items removed from the general matrix (Yalden 1977). The matrix was scanned under a microscope for earthworm chaetae and insect remains (eg chitinous jaws of caterpillars). Mammal hair identification was initially based on shape, size, texture and pigmentation. If identification was not achieved, microscopic analysis was then used. Casts of guard hairs were made on a film of 5% gelatin solution on a microscope slide. After the gelatin hardened, the hairs were removed and the imprint of the cuticular scale pattern was used for identification.

Finally, confirmation of identification was based on the pattern of medullary cells, viewed at a magnification of x400, of hairs mounted in 70% ethanol (Day 1966). Bird identification was based on the lower barbs of feathers which were mounted in 70% ethanol, allowing the characteristics of the barbules to be seen at magnifications of x200 to x400 (Day 1966).

During the breeding seasons of 1994 and 1995, 8 and 14 nests were visited respectively and prey remains within and below the nests were identified and counted. If prey was dismembered, the numbers of limbs, wings and other identifiable parts were taken into account when counting items and minimum numbers estimated.

Results

Diet

In winter, the most frequently identified prey in pellets was the Rabbit, followed by sheep, voles, worms and insects (Table 1). Identified insects included caterpillars and beetles. Passerines included thrushes and Robins *Erithacus rubecula*.

In summer, the most abundant and frequently found prey item was again the Rabbit (Table 2). Corvids were the next most important prey. Three Chaffinch nests were found at Red Kite nests. It seems likely that the kites had plucked the entire nest from its site and eaten the contents.

Table 1 ***The percentage occurrence of prey items in 40 pellets of Red Kites in winter and early spring in northern Scotland. See Table 2 for scientific names.***

	January	February	March	April	All months
Sheep	40	30	30	20	30
Rabbit	90	80	50	60	70
Rat	0	10	10	0	5
Voles	20	30	30	40	30
Mice	0	0	20	0	5
Mole	20	30	0	20	18
Shrews	0	0	10	0	3
Ducks	0	10	0	0	3
Galliformes	0	20	20	20	15
Gulls	10	10	20	30	18
Pigeons	30	0	10	0	10
Corvids	10	10	10	30	15
Other Passerines	20	40	10	20	23
Worms	10	20	40	50	30
Insects	30	30	30	30	30
No of pellets	10	10	10	10	40

Table 2 ***The diet of breeding Red Kites in summer in northern Scotland in 1994 and 1995 from items identified at or near the nest.***

PREY ITEMS		1994 Percent by number	1994 Percent occurrence	1995 Percent by number	1995 Percent occurrence	Both years Percent by number	Both years Percent occurrence
Rabbit	*Oryctolagus cuniculus*	51.5	100	59.2	93	55.2	95
Brown Hare	*Lepus capensis*	-	-	0.8	7	0.4	5
Voles		3.7	38	0.8	7	2.3	18
Mole	*Talpa europaea*	0.8	13	-	-	0.4	5
Brown Rat	*Rattus norvegicus*	0.8	13	1.6	14	1.2	14
Sheep/lambs	*Ovis aries*	1.5	25	2.4	14	1.9	18
Hedgehog	*Erinaceus europaeus*	0.8	13	2.4	21	1.5	18
Roe Deer	*Capreolus capreolus*	0.8	13	-	-	0.4	5
Mussel	*Mytilus edulis*	0.8	13	-	-	0.4	5
Crab		-	-	0.8	7	0.4	5
Flounder	*Platichthys flesus*	1.5	25	0.8	7	1.2	14
Lumpsucker	*Cyclopterus lumpus*	-	-	0.8	7	0.4	5
Invertebrates		4.5	13	-	-	2.3	5
Piece of lard		0.8	13	-	-	0.4	5
Piece of roast meat		-	-	0.8	7	0.4	5
Shag	*Phalacrocorax aristotelis*	0.8	13	-	-	0.4	5
Domestic hen	*Gallus gallus*	-	-	0.8	7	0.4	5

Table 2 contd ***The diet of breeding Red Kites in summer in northern Scotland in 1994 and 1995 from items identified at or near the nest.***

PREY ITEMS		1994 Percent by number	1994 Percent occurrence	1995 Percent by number	1995 Percent occurrence	Both years Percent by number	Both years Percent occurrence
Pheasant	*Phasianus colchicus*	-	-	4.0	21	1.9	14
Waders		0.8	13	-	-	0.4	5
Herring Gull	*Larus argentatus*	1.5	13	0.8	7	1.2	9
Gulls		4.5	25	-	-	2.3	9
Feral Pigeon	*Columba livia*	1.5	25	0.8	7	1.2	14
Woodpigeon	*Columba palumbus*	6.0	38	8.0	36	7.0	36
Swallow	*Hirundo rustica*	-	-	0.8	7	0.4	5
Song Thrush	*Turdus philomelos*	-	-	0.8	7	0.4	5
Chaffinch	*Fringilla coelebs*	0.8	13	-	-	0.4	5
Chaffinch nest		1.5	25	0.8	7	1.2	14
Corvids		15.7	100	12.8	57	14.3	73
Number of items		134		125		259	

As well as preying and scavenging on small mammals and birds, the Red Kites also scavenged on larger mammals (sheep and deer) and on household refuse (pieces of lard and roast meat). The kites also visited the seashore to obtain marine invertebrates, fish and dead seabirds (auks and gulls).

Foraging behaviour

Red Kites foraged in a variety of habitats and employed a number of feeding methods. A commonly observed hunting method was a slow flight 3-5 m above the ground before pouncing on small mammals in fields of pasture and stubble. Food became unavailable on pastures when the grass became long but when silage was cut in May small mammals became available again. A harvested pea field attracted many birds of prey with a maximum count of 18 Red Kites plus 22 Buzzards *Buteo buteo*. In spring, Red Kites were seen on freshly ploughed land along with gulls and Buzzards, feeding on worms and, presumably, other invertebrates.

Away from farmland, a Red Kite was seen swooping down from a perch in a Beech *Fagus sylvatica* wood to catch a small mammal and kites were seen taking moths from Heather *Calluna vulgaris*. Red Kites are very manoeuvrable in flight and were seen hawking large insects, perhaps crane flies *Tipulidae*. They also visited rookeries during the breeding season in search of young Rooks *Corvus frugilegus*, despite being persistently mobbed by adult Rooks.

Kleptoparasitism was observed against a Kestrel *Falco tinnunculus*, robbing it on the ground of a rat, and a Sparrowhawk *Accipiter nisus*, robbing it in flight of a Blackbird *Turdus merula*. An immature Red Kite was also seen snatching a broken Mussel *Mytilus edulis* which a Hooded Crow *Corvus corone* had just dropped on the foreshore and was about to retrieve (B Etheridge *pers comm)*. Mussel shells were regularly found below roosting trees during the winters 1994-1996 suggesting that the kites obtain many Mussels.

Rabbits and Pheasants *Phasianus colchicus* which had been killed on the road were observed being scavenged. This hazardous behaviour has led to at least 3 Red Kites being struck by cars. Red Kites also scavenged Rabbits that had been shot and left in fields by farmers. Scavenging in villages was also observed. At least 4 households left out food for Red Kites in gardens or on bird tables. The food provided included Rabbits, mice, birds and fish protein pellets. Other food not specifically put out for Red Kites was also taken. This included lard, cooked meat, bread and kitchen slops.

Discussion

Prey from the 2 seasons was identified using different methods, both of which have inherent and different biases. Pellet analysis revealed that the Red Kites were eating earthworms, even in winter. None were, however, found as prey remains at nests. Such small items are probably eaten entirely and any remains quickly disintegrate. It is likely, in the pellet analysis, that prey containing little indigestible material would be less likely to be found than prey with a high amount of indigestible material. Remains of smaller animals are also more likely to be overlooked than those of larger animals.

The diet of Red Kites in northern Scotland showed some similarities and contrasts to elsewhere. In Sweden, the country of origin of the birds released in Scotland, Red Kites primarily take road kills and waste from farms and rubbish dumps in winter (Kjellén 1996).

During the breeding season, however, their diet is broader and based mainly on birds (76% of items), particularly young Corvids, but also Pheasants, gulls, pigeons and Starlings *Sturnus vulgaris*. Rabbits and small rodents make up most of the mammal prey. Those nesting close to lakes take many fish (Kjellén 1996). The main contrast with Sweden is, therefore, the differing percentages of Rabbits: 55% by number in Scotland compared to 5% in Sweden.

The main contrast with the diet of the native Red Kite population in Wales is in the relative use of sheep carrion (Davies & Davis 1973). This is a major food source the year round and appears to be peculiar to the sheepwalks of Wales. Elsewhere in the range of the Red Kite, sheep carrion is of minor importance (Cramp & Simmons 1980). The recent development of a new roost in northern Scotland in an area of sheep walk will, however, probably result in a greater use of sheep carrion.

In the southern part of their range in Europe, Red Kites take many reptiles (Garzón 1974, Manzi & Pellegrini 1992) which are absent from the diet in Scotland.

If Red Kites continue to use Rabbits as a major food source, there is a concern that the current spread of Rabbit Haemorrhagic Disease may severely reduce the Rabbit population as did Myxomatosis when it first appeared. This may have a detrimental effect on the Red Kite population as it continues to establish itself in Scotland. Of more immediate concern is that by scavenging on Rabbits killed on the road, the kites themselves become vulnerable to being killed by cars. Their habit of scavenging shot Rabbits also means that they are likely to ingest lead shot which can result in lead poisoning (Pain *et al* 1993).

It is likely that the success of the reintroduction, in terms of good breeding performance and population growth (Evans *et al* in press), is in part due to the plentiful supply of Rabbits which forms much of the diet. The area where most Red Kites are nesting also has a high density of Buzzards which also prey on Rabbits (Swann & Etheridge 1995). At present, there is no overt indication that the 2 species are competing, suggesting that prey is super abundant.

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Breeding biology of Swallows in Easter Ross

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During the 1980s the Swallow population steadily declined, especially in south and east England, and the species is now considered to be of conservation concern. This study monitored the number of Swallows breeding in an area of Easter Ross, Highland, over a 3 year period and examined their breeding success. Results are compared with other studies and possible causes of decline in the numbers of breeding Swallows discussed.

Methods

We decided to study the numbers and breeding success of Swallows *Hirundo rustica* breeding in Easter Ross to compare this population with breeding Swallows studied elsewhere in the UK. During the summers of 1992-1994 regular visits were made to an area of Easter Ross to record the contents of every accessible Swallow nest and to ring the nestlings. Each nest was visited once every 7 to 10 days between mid May and mid September by which time the last young birds had left the nest.

The study area consists of a series of derelict wartime buildings on a disused airfield at Fearn and Loans of Tullich. Less than 10m asl, the site covers approximately 4sq km of mainly arable farmland, with some improved grassland grazed by sheep and cattle. A variety of nest sites are available, ranging from low concrete air raid bunkers less than 2m high, to tall brick towers over 5m high. The outbuildings of a disused croft are also utilised. Human disturbance is considered to be minimal, although some buildings are used on a casual basis by sheltering livestock.

Each room in a building which contained an active or old Swallow nest was numbered to avoid any confusion when recording contents. Because of the large number of nest sites available, each room generally held only one pair of Swallows. Occasionally a large room, or a long corridor within a building, held 2 pairs at opposite ends. These nests were generally out of sight of each other, although they sometimes shared a common entrance. It was assumed that, after a successful nesting attempt, a further nesting attempt in the same room was initiated by the same pair. There was no evidence to suggest that pairs moved to a different building, or room, after a successful first brood. Occasionally, however, after a failed first attempt a new nest was started in an adjacent unoccupied room within the same building. This was assumed to be the same pair relocating. In 1992 a small number of nests were not accessible but it was still possible to include these in the total number of breeding pairs and to determine their success or failure.

First egg dates were calculated assuming an incubation period of 15 days. This was based on observations of nests where the date of laying of the final egg and the date of hatching were both known. This assumes that incubation began with the laying of the final

egg and that eggs were laid at one day intervals. This period also closely follows Adams (1957) who found a mean incubation period of 15.25 days from an analysis of national nest record card data.

During the autumns of 1992-1994 regular visits were made to the reed bed roost at Loch Achnacloich, near Ardross in Easter Ross. Here we tape lured and trapped Swallows for ringing between mid July and mid September. All birds caught were aged as adults or juveniles according to Svensson (1992).

Results

Breeding numbers

Although full data were not collected during the 1991 breeding season, the study site was visited on a regular basis to ring the nestlings. At this time the population stood at 90-95 pairs. Numbers were lower at 69 pairs in 1992, 50 pairs in 1993, and 38 pairs in 1994, the population having fallen by 45% between 1992 and 1994. Further visits were made in 1995 and 1996 to ring nestlings and count the total number of pairs. The population in 1995 was found to have further declined to 30 pairs but had stabilised at 30-31 pairs in 1996.

Timing of breeding

Generally the first eggs were laid around the middle of May, however the peak laying period varied, with median dates for first eggs being 24 May (n=56) in 1992, 26 May (n=38) in 1993 and 29 May (n=31) in 1994. Most clutches were begun by 10 June. In each of the 3 years less than 10% were begun between then and the latest recorded date of 25 June in 1992. After successfully rearing a first brood there was a delay of between 2 and 25 days before a second clutch was started. The average delay was 11.9 days (n=78, sd =4.04). Additionally 2 pairs are known to have started a second clutch in an adjacent nest in the same room 2 days before their first brood had fledged. There was no evidence of any attempts to rear a third brood following 2 successful attempts. Only one pair managed to successfully rear 2 broods after their first nesting attempt had failed at an early stage. There were no records of any pairs starting a third nesting attempt when their second attempt had failed after a successful first attempt. Most fledgling swallows had left the nest by the end of the first week in September with the latest recorded date being 17 September 1992.

Clutch size

In the study area the clutch size ranged from 3 to 6 eggs, with one exceptional clutch of 7 which fledged 7 young. The average clutch size varied little between years, being 4.81 (n=96, sd=0.68) in 1992, 4.82 (n=72, sd=0.63) in 1993 and 4.81 (n=57, sd=0.63) in 1994. The average size of clutches begun in each month showed a steady decline from 5.05 in May (n=89, sd=0.62) to 4.73 in June (n=41, sd=0.70) and 4.61 in July (n=92, sd=0.59). June clutches were significantly smaller than May ones ($t = 4.051$, $p < 0.01$). July clutches were not, however, significantly smaller than June ones ($t = 1.622$, ns). The only clutch started in August contained 4 eggs. The average first clutch size was 4.96 (n=124, sd=0.68) and the average replacement clutch of 4.92 (n=14, sd=0.46) was not significantly different. The average second clutch size of 4.61 (n=80, sd=0.58) was, however, significantly smaller ($t = 5.833$, $p < 0.01$) than the first clutch. During the 3 years of our study 4.3% of the 1078 eggs laid were found to be addled.

Breeding success

In the 3 year study period, one nest was deliberately destroyed by humans and one nest was predated, probably by a feral cat. The average number of young fledged per nest was 3.34 (n=103, sd=1.94) in 1992, 3.40 (n=85, sd=2.08) in 1993 and 4.00 (n=60, sd=156) in 1994, showing no significant variation between years. The average for the 3 year study period was 3.52 (n=248, s.d.=1 .93). The number of pairs successfully rearing 2 broods was 43.5% (n=62) in 1992, 44% (n=50) in 1993 and 52.6% (n=38) in 1994. There was no significant variation between years (x^2 = 0.78, ns). The number of young fledged per pair varied from none to 13, the average being 5,55 (n=62) in 1992, 5.78 (n=50) in 1993 and 6.45 (n=38) in 1994. This again showed no significant variation between years and overall averaged 5.85.

Another way of measuring breeding success is to calculate the number of young fledged as a percentage of the total number of eggs laid in nests of known outcome. This showed a steady increase from 74.46% (n=462) in 1992, to 83.29% (n=347) in 1993 and 87.59% (n=274) in 1994. This gives a 17.6% increase in breeding success between 1992 and 1994, which was highly significant (x^2 = 26.705, $p < 0.001$). This was partly due to very few pairs, 3 out of 38 (7.8%) failing to rear any chicks at all in 1994, compared with 15 out of 112 (13.4%) in 1992-93.

Autumn trapping

The percentage of juvenile Swallows trapped at Loch Achnacloich in autumn remained stable at 88.5% (n=1052) in 1992, 88.21% (n=653) in 1993 and 88.36% (n=524) in 1994. However the total numbers of birds trapped mirrored the decline in population levels in the study area, the trapping effort being fairly constant. Ringing recoveries of birds trapped at this site indicate that they are predominantly of local origin with only a very small number of birds from further north being trapped on passage.

Discussion

The average clutch size of 4.81 is slightly higher than the average of 4.66 found by McGinn and Clark (1978) in Lothian, and the 4.01 to 4.09 found by Boyd (1936) in a sample biased towards southern Britain. This lends further support to the findings of Boyd (1936) who states that average clutch size should increase with latitude. This suggests that there is an association between the longer hours of daylight in the northern summer and, therefore, more time to gather food for the nestlings, and larger broods. Average clutch size declined from May to July, confirming the findings of McGinn and Clark (1978) who found a decline from an average of 5.06 in May to only 4.08 in August, and Adams (1957) who found an average of 4.7 in April decreasing to 4.3 in July. The 4.3% of eggs addled is a much lower figure than the 7.2% given by McGinn and Clark (1978) and the 10% quoted by Boyd (1936).

The number of young birds fledged as a percentage of the number of eggs laid suggests a possible density dependent effect where breeding success increased as the number of pairs decreased. The figures of 74.5% in 1992 rising to 87.6% in 1994 show that the population enjoyed better breeding success in 1993 and 1994 than the populations studied by McGinn and Clark (1978) and Adams (1957), who give figures of 76.3% and 71.9% respectively.

Between 1992 and 1994 the number of Swallows breeding in the study area fell by 45%, and, despite the apparent increase in breeding success, continued to decline in 1995. There is no evidence to suggest that this was due to emigration from the study area to other parts of Easter Ross. During the period 1991 to 1994 visits were made to many other sites in Easter Ross to find Swallow nests and ring the nestlings. Many pairs nesting in isolated farm buildings and old croft houses are known to have also disappeared at this time. Evidence suggests that the number of pairs breeding near Nigg, some 6km south of the study site, fell by more than 60% during the study period (*pers obs*). Swallows are known to be very site faithful (Turner 1994), with adult birds frequently returning to breed at exactly the same site each year. Juveniles are also known to return to breed close to their natal area. The habitat in the study area appeared to remain stable throughout and the lack of change in breeding success suggests that local environmental effects had no part to play in the decline.

According to Turner (1994), first year mortality of juvenile Swallows ranges between 70% and 90%, and annual mortality of adults between 43% and 73%. If we take the middle value of these ranges (ie 80% mortality for juveniles and 58% for adults), then it is possible to calculate that an average of 5.8 young fledged per pair per year should be sufficient to sustain the population. Based on these figures, the Easter Ross population appears to be producing enough young each year to maintain itself at a stable level, the annual production of young birds ranging from 5.55 to 6.45 young fledged per pair. This suggests that the reason for the decline lies elsewhere, either during the non breeding season in southern Africa, or on passage to or from this area.

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A survey of Storm Petrels on the Treshnish Isles in 1996

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A survey of Storm Petrels in all accessible habitat on the Treshnish Isles was undertaken during 9-29 July 1996. The survey method used was diurnal playback of the male's 'purr' song. To estimate the population of Storm Petrels, it was necessary to determine the probability that a bird would respond to playback. To estimate this, playback was repeated over 8 successive days at stone wall and boulder beach sample plots. On the assumption that all occupied burrows were located over the 8 successive visits, it was possible to calculate that any single playback visit elicited responses from 36% of occupied burrows. Using this response probability the total population of breeding pairs of Storm Petrels on the Treshnish Isles in 1996 was estimated to be 5,040. The majority of Storm Petrels 3,120, were present on the island of Fladda which was largely surrounded by suitable boulder beach habitat. Most colonies were in boulder beach, or scree, or rubble mixed with soil with some short ground vegetation. There was a higher density of birds in this type of habitat when the boulders had a covering of tall vegetation.

Introduction

The Storm Petrel *Hydrobates pelagicus* is the smallest of the Atlantic petrels with a breeding distribution limited to the western Mediterranean and coasts of the eastern north Atlantic. Storm Petrels have amber listed status (Gibbons *et al* 1996) with breeding populations localised in the UK, virtually endemic to Europe and threatened by the possible introduction of mammalian predators. In the UK the majority of colonies occur on offshore islands along the west coast. The Treshnish Isles are a string of small islands west of Mull which were designated a Special Protection Area in 1994 under the EC Wild Birds Directive (Fig 1). The only surveys of the breeding birds on the Treshnish Isles over the last 20 years have been by the Treshnish Isles Auk Ringing Group (Walker and Cooper 1996). They estimated that 2,000 pairs of Storm Petrel bred in the large boulder beach on Lunga. This number was estimated by measuring the area of the beach and assuming one pair of Storm Petrels was present in each square metre. The apparently high density was confirmed by the large numbers of birds seen and caught in mist nets at night. Walker and Cooper (1996) also found Storm Petrels on the island of Fladda and thought it likely that they would occur on all of the larger islands in the Treshnish group.

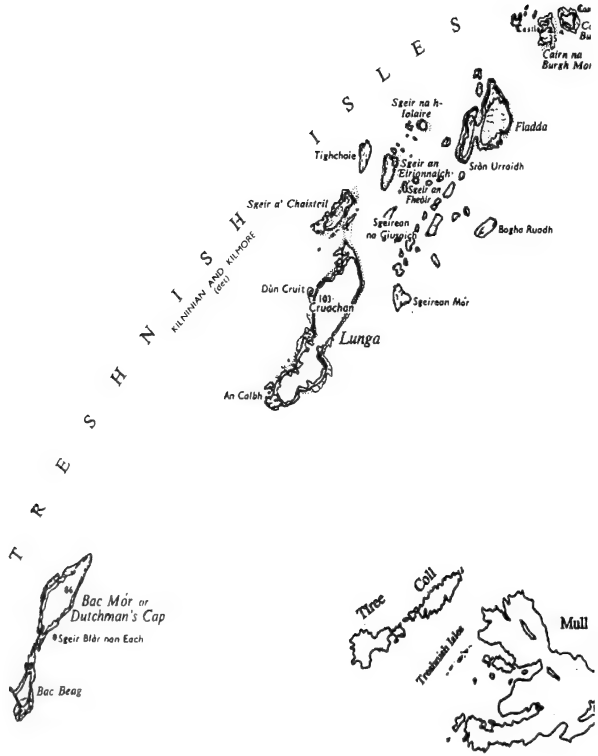

Figure 1 *The Treshnish Isles.*

Study Site

The Treshnish Isles consist of 7 larger islands, Lunga, Fladda, Dutchman's Cap (Bac Mór), Little Dutchman (Bac Beag), Sgeir a' Chaisteil, Cairn na Burgh More and Cairn na Burgh Beg), 3 small vegetated islets (Sgeir an Eirionnaich, Sgeir an Fheòir and Sgeir na Giusaich) and a large number of skerries. All of the larger islands are surrounded to some extent by sheer cliffs, with gullies and boulder scree, but the extent to which the boulder scree is covered by the high water mark varies between islands. The larger islands have very distinctive terraced outlines caused by weathering of Tertiary basalt (Walker and Cooper 1996). The islands have been uninhabited since about 1860, but the remains of walls, houses, churches, garrisons and other buildings are present on all the larger islands.

Methods

There is no standardised method of counting breeding Storm Petrels and, therefore, there has been no accurate monitoring of the breeding population. The world population of Storm Petrels has been estimated at between 135,000 and 380,000 pairs with an estimated British population of between 20,000 and 150,000 pairs Lloyd *et al* 1991). Recent studies (Mainwood *et al* 1997; Ratcliffe *et al* 1996; Vaughan and Gibbons *in press)* discuss census methods such as nocturnal mark and recapture studies using mist netting data and nocturnal counts of vocalisations. However, they suggest that diurnal playback of the male's song is the best method currently available. Diurnal playback is preferable to nocturnal surveys, as surveying in daylight is less hazardous, allows more accurate mapping and enhances visual detection of suitable habitat. There is also an unknown proportion of burrows occupied by non breeding birds which is larger at night than during the day (Mainwood *et al* 1997*).*

Response probabilities

Diurnal playback will not detect every pair of breeding birds in a single visit and to calculate the total population it is necessary to obtain a correction factor based on response probabilities. A tape played back at a burrow entrance may fail to elicit a response either because there is no adult in the burrow or the adult may fail to respond. These 2 factors combine to give an overall response probability. Almost every survey which has used the diurnal playback method has come up with a different correction factor and therefore a different way to calculate the overall population. Mainwood *et al* 1997 use the mean figure from 2 studies, giving a correction factor of 74%. These studies (on Skokholm and Mousa) used an equation from James and Robertson (1985) to derive response probabilities for nest sites where the presence of birds was known. The overall response probability was estimated in the present study by repeatedly sampling occupied habitat types which initially contained unknown numbers of Storm Petrels and without the use of James and Robertson's (1985) equation. Using a similar procedure Vaughan and Gibbons *(in press)* found a 34% response probability.

The aims of this project were to investigate the probability of diurnal detection of Storm Petrels on the Treshnish Isles in order to estimate the size of the breeding population.

Additional data on playback response types were also collected to allow a population estimate to be calculated using other published methods.

Timing

Fieldwork was carried out between 9 July 1996 and 29 July 1996 in order to coincide with the peak of the incubation period, when the largest numbers of birds are on eggs. It was assumed that peak incubation would be between the known peak dates for Skokholm (approximately 10 July) and Mousa (approximately 2 August) (Ratcliffe *et al* 1996).

Sample survey plots

It was necessary to estimate a mean response probability using sample survey plots of representative habitat types. Plots of wall habitat and boulder beach habitat were chosen on the island of Lunga as sites where playback was repeated during the day for 8 days (10 July 1996 to 17 July 1996). The time of day of playback was varied. A total of 260m of wall was sampled in 8 separate sample lengths in various parts of the island. Five areas of boulder beach were selected in the area of the landing beach at Lunga where previous observers had noted large numbers of birds. Each boulder beach sample plot was 25 m^2, (5x5 m). The tape (a good quality recording of a purring male from Mousa) was played back at the base of each wall at 1m intervals and from the same positions every day. The 5 boulder beach quadrats were each marked into 25 x lm squares using white matt removable spray paint. The tape was played back in the centre of the 25 squares on each visit. Playback lasted 10 seconds, each response, and its type, was noted and the burrow entrance numbered. Numbers were written with waterproof markers onto strong adhesive tape which was stuck to the entrances. This proved very effective; none of the tape was washed off during the survey, but it was all quickly removed at the end. In an attempt to control for any effect of site and plot, the boulder beach plots were on different aspects of the boulder beach. This resulted in the plots having different mixes of boulder size, different amounts of vegetation cover and different mixtures of boulder and soil. The wall sample plots were of different lengths, heights and thickness. They faced the sea in north, south, east and westerly directions.

Calculating response probability

The data on detection probability (response/ no response) were analysed using logistic regression. It was assumed that each site in each habitat was detectable over the 8 days of repeated sampling. Habitat (wall or boulder beach) and visit number (1-8) were included in the regression model as categorical variables. A forward stepwise method was used with a likelihood ratio probability of 0.05 as the maximum criteria for inclusion in the model. This analysis would detect any overall effect of the habitat type (wall vs boulder beach) on the likelihood of getting a response, or an effect from the different visits themselves, as well as providing a figure for the probability of detection.

Whole islands survey

All potential Storm Petrel breeding habitat was surveyed once during daylight hours using the same method of song playback as for the sample plots. The same tape and playback equipment were used as for the sample plots. The type of response was noted. If faint or unrecognisable calls were heard the playing of the tape was repeated to elicit further response. This was also sometimes necessary to clarify the situation for areas in which several birds responded simultaneously.

At wall sites the tape was played at the base

of one side of the wall at 1m intervals, and for higher walls again at 1m intervals at a height of 1m. Boulder beaches were surveyed by 2 people using playback in 1m parallel transects. In areas where the boulder scree was half buried in the soil and widely distributed on island tops, any gaps under boulders and potential burrows were surveyed. Thick bracken, caves and accessible cracks in cliffs and rocks were also surveyed. Areas where individuals were separated by more than 10m were considered to be different groups. Each group was plotted on a map of the island being surveyed and the number and type of responses were recorded.

On several occasions the locations of small discrete groups of Storm Petrels were initially discovered by listening at night. With complicated shorelines and cliffs of various heights, it was also found that use of a boat was extremely helpful. The only areas that were not surveyed were those such as cliff faces that were inaccessible.

We compared the estimated populations of Storm Petrels on each island calculated from our own repeated sampling with those calculated from an equation formulated by James and Robertson (1985) in their playback studies.

Habitat

The type of habitat was noted for each group and where possible an estimate of the area of the habitat occupied by Storm Petrels was made in the field and from maps. The length and height of walls was estimated to allow area comparisons with other non-linear habitats. The habitat occupied by Storm Petrels on Treshnish could be split into 8 basic categories:

1 Boulder beach, not mixed into a composite with soil, with no vegetation cover

2 Boulder beach, or scree, or rubble and soil composite with some short ground vegetation, but no tall vegetation cover

3 Boulder beach, or scree, or rubble and soil composite with some short ground vegetation, but also with tall vegetation cover

4 Walls still relatively intact with tall vegetation cover

5 Walls still relatively intact with no tall vegetation cover

6 Caves

7 Cracks in cliffs

8 Burrows in soil

Tall vegetation cover was either Bracken *Pteridium aquilinum,* Bramble *Rubus fruticosus,* Bramble and Honeysuckle *Lonicera periclymenum,* or Nettles *Urtica dioica.* Short ground vegetation was mostly grasses.

Results

Over the 8 daily visits a total of 57 occupied Storm Petrel sites were detected in the boulder quadrats and 83 in the wall plots. Logistic regression analysis revealed no overall effect of habitat type ($P = 0.212$; $df = 1$; $G^2 = 1.56$) or visits ($P = 0.062$; $df = 7$; $G^2 = 13.45$) on response rates. The probability of getting a response to playback from any site on any day was 0.36.

Table I ***Number of groups, number of responses to playback recorded and population estimates based on the 36% response rate found in the present study from repeated playback at sample plots and on James and Robertson's (1985) equation.***

Island	No of groups	Total No of responses	Number of "purr" responses	Number of "terr-chick" responses	Population est based on James & Robertson's (1985) equation	Population est based on 36% response rate
Lunga	50	332	91	241	515	922
Sgeir a' Chaisteil	3	31	7	24	52	86
Dutchman's Cap Bac Mór	11	70	27	43	90	194
Dutchman's Cap Bac Beag	3	19	7	12	25	53
Fladda	27	1,123	300	823	1,762	3,119
Cairn na Burgh Beg	5	8	4	4	8	22
Cairn na Burgh More	12	232	63	169	362	644
Treshnish Isles Total	111	1,815	499	1,316	2,814	5,040

The playback response probability of 0.36 was applied as a correction factor to the playback responses recorded in the whole islands survey. Table 1 gives island by island population estimates using both our own 0.36 correction factor and James and Robertson's (1985) equation.

Most of the groups (87%) were recorded in habitat types 1 to 5 with habitat 2 hosting the most groups (47%). The density of each Storm Petrel group was measured as total responses per 10 m^2. Table 2 shows the mean density for each of the 5 important habitats. There was a significant difference in the density of Storm Petrels amongst the 5 habitat types (Kruskal-Wallis one way analysis of variance; H = 27.1; df = 4; P=0.0001), with walls holding the highest densities. Of the boulder/scree habitats (1-3) there was a higher density of Storm Petrels amongst boulders which had some tall vegetation cover (habitat 3) (Mann Whitney U test; U = 204; 2- tailed P = 0.042; n_1 = 10, n_2 = 68).

Discussion

This was the first comprehensive survey of Storm Petrels on the Treshnish Isles. The total breeding population was estimated to be 5,040. Using James and Robertson's (1985) equation the population was estimated to be

Table 2 ***The mean density of Storm Petrels in 5 different habitat types, where density is measured as the number of pairs per 10 m2 in each group. The Storm Petrel groups are from all of the Treshnish Isles and the habitat types (1-5) are explained in the text.***

Habitat Type	No. of Groups	Mean Group Density (Pairs/10m²)	Standard Error
1	16	0.098	0.018
2	52	0.345	0.099
3	10	0.606	0.332
4	3	0.642	0.216
5	16	1.36	0.338
Total	97		

2,814. Our correction factor of 36% calculated to assess the probability of a Storm Petrel responding to playback was similar to the 34% calculated by Vaughan and Gibbons *(in press).* We believe that the application of the 36% response rate found on site gives a better representation of the actual population than that of an unrelated response rate (eg Mainwood *et al* 1997; James and Robertson 1985).

The figure of 2,000 breeding pairs estimated by Walker and Cooper (1996) for the landing beach at Lunga is considerably higher than our estimate of about 350 pairs for the same area. Walker and Cooper's (1996) estimate was made at night when birds move around and additional non breeding birds come in to land, inflating the apparent population size. Also, this boulder beach faces nearby Fladda where by far the most Storm Petrels were found during the present survey. Therefore, the differences in estimates for the landing beach at Lunga are probably due to an initial overestimate rather than representing a decline in numbers between the 2 dates. It is also true, however, that without Walker and Cooper's (1996) observations of the large numbers of Storm Petrels in this area, the present survey may not have been initiated. The population estimate of 5,040 breeding pairs of Storm Petrels on the Treshnish Isles may include some non breeding birds. However the proportion of non breeding birds within colonies is highest during the night and is thought to be less significant during the day (Mainwood *et al* 1997*).* It is impossible to say how many Storm Petrels were missed by not surveying inaccessible places.

The diurnal playback method used to carry out the survey was straightforward and practical. The playback equipment was light and could be used with one hand. Much of the terrain surveyed was quite dangerous and it was important to have one hand free. One of the main advantages of the survey was the flexibility of being able to work at any time of

the day. Some caves, gullies and islands could only be visited when tide conditions allowed and much of the terrain could not have been covered if a night time survey had been used. The method is also repeatable which allows for future monitoring of part or all of the Treshnish Isles. Results from playback experiments on Mousa show that the time of day does not significantly affect the response rate (Ratcliffe *et al* 1996), although the repeat playback carried out when responses were weak or confused may have occasionally located new birds and slightly increased the number of responses noted.

Although the method was as standardised as possible it is still unclear why the response rate is so low. There are many factors which may influence the probability of a bird responding for example: the stage of the season; the number of days a bird has been incubating (Mainwood *et al* 1997); the volume of the speakers; the particular male song used for playback and the strength and direction of the wind. Variation in these factors between surveys and between sites could lead to differences in response rates.

Mainwood *et al* 1997 found most Storm Petrels in peat burrow systems and in peat cracks under heather. On the Treshnish Isles the densest groups were found in walls and boulder/scree particularly when covered by tall vegetation. There may be some advantage to Storm Petrels to breed amongst boulder piles covered by vegetation, rather than bare boulder piles. They must be at their most vulnerable to predation as they land and a cover of thick vegetation may offer some protection from predators, such as Great Black-backed Gulls *Larus marinus*.

Storm Petrel *Andrew Stevenson*

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The status of Storm Petrels on Mousa, Shetland

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The population status of Storm Petrels on Mousa was estimated from a diurnal playback census during the incubation period. Sample sections of drystone wall and transects in all occupied natural sites (boulder beaches and rock scree) were surveyed using playback of male purr calls and responses of birds in Apparently Occupied Sites (AOSs) were counted. Boot strapped means of AOS density were calculated within walls and natural sites and extrapolated to the entire area of these habitats. Observations of response rates at a sample of accessible nest sites suggested that only 25% of occupied nests respond to playback, so the estimates were multiplied by a correction factor. The population was thus estimated at 6,800 ± 2,000 Apparently Occupied Sites, with 56% occurring in the islands drystone walls and the rest in areas of boulder beach and rock scree. This estimate is higher than that found in 1992 for this island but the interpretation of the trends requires caution since the census methods differed between years.

Introduction

Storm Petrels *Hydrobates pelagicus* are difficult to census with any degree of accuracy due to their nocturnality, the presence and behaviour of large numbers of non breeders and the remoteness of their colonies (Lloyd *et al* 1991). The nesting habitats include cracks in rock or peat, burrows in soil and in cavities among boulder scree, boulder beaches and in dry stone walls. In the latter 3 cases there are no apparent entrances to the nest to count, and so this further complicates census work.

The estimates of Storm Petrels status presented in Lloyd *et al* (1991) are little more than guesses at the abundance on known breeding islands. These figures suggest that the Storm Petrels in Britain and Ireland represent 51-65% of the world population, the other main population being in the Faroes (Lloyd *et al* 1991). This species is thus of major conservation concern in Britain and Ireland on the basis of its international importance, so it is essential to develop methods to monitor their populations. Mousa is thought to support an important Storm Petrel colony and Lloyd *et al* (1991) estimated the population of the island to be between 1,000 and 10,000 pairs. Mapping the location of calling birds at night has subsequently been used to estimate the population there more accurately (Suddaby 1992), giving an estimate of 4,500-5,000 calling birds. James and Robertson (1985) advocated the use of diurnal playback of conspecific calls to elicit

vocal responses from incubating birds as a method for censusing petrels, and this has been applied to several British Storm Petrel colonies. During July, when birds are incubating, the burrow occupancy for Storm Petrels is high (Davis 1957, Scott 1970, Bolton 1996) and playback of the male purr call (James 1984) will elicit a proportion of the birds present to reply. In order to calculate the population status, the attendance and response probability must be known and a correction factor based on these data applied to the initial estimate (James and Robertson 1985). Estimates of diurnal response rate for Storm Petrels have varied between 0.25-0.75 (for review see Ratcliffe *et al* 1997a).

This report presents data from a sample census of Mousa using diurnal playback methods in 1996. During this year detailed studies of response probabilities and attendance were carried out at known nest sites (Ratcliffe *et al* 1997a), thus allowing accurate correction factors to be generated for Mousa in the same year as the census.

Study site and methods

Mousa is a small, low lying island situated off the coast of south west Shetland. It has 15 visually distinct, natural areas of loose rocks and boulders in which Storm Petrels can be found. All of these, except the Broch boulder beach, are well above and set back from the intertidal zone. They range in type from very rounded boulder beach through to piles of flat sandstone slabs with varying amounts of vegetation and earth among the stones. The drystone walls on the island are less than 1m thick and are in varying states of repair, with many sections containing both intact and ruined lengths.

The whole island was surveyed for sub colonies at night by listening for purr calls during May when males are most vocally active (Scott 1970, Ratcliffe *et al* 1996) and their locations were plotted on a large scale map. The census work was carried out between the 26 July and the 9 August when most breeding birds were thought to be incubating eggs or young chicks (Bolton unpublished data). Breeding in 1996 seemed to be earlier than in 1992, with the peak of nest attendance being highest in mid July (Ratcliffe *et al* 1997a), resulting in the latter part of the census being marginally late.

A recording of a male Storm Petrel purr call (James 1984) that was recorded on Mousa was used for the playback survey. The sound equipment was a personal stereo with amplified speakers. In all habitats, the playback volume was 80dB and this was played for 10 seconds duration. Any responses elicited during a 30 second period following the playback were noted. The walls on the island were divided into 100m lengths and 10 of these sections were selected at random for survey. The tape was played along the base of the walls because Storm Petrels only nest at ground level on Mousa. The tape was played at 1m intervals along one side of the walls because a recording played 1m from a nest produced similar response rates to those played right next to it (Ratcliffe *et al* 1997a).

All of the 15 separate areas of natural habitat were sampled using 1m wide parallel transect lines spaced at 5m intervals. Transects started and finished at the first and last section of suitable habitat and so were variable in length. The tape was played every 1m along the middle of each transect if the point was over apparently suitable nesting habitat (ie scree with cavities that would be large enough to

accommodate a Storm Petrel nest). The Broch boulder beach was sampled using 4 randomly selected 25m^2 quadrats. The tape was played at the intersections of a 5 x 5 m grid plotted within the quadrant.

The number of responses from adult birds for each sample was summed and divided by the length of wall or the area of natural sites to give an estimate of the density of AOSs (Apparently Occupied Sites). Calls from chicks were not included in final census estimates as the correction factor used to estimate the numbers of birds missed during playback census is based on adult response only.

The total length of walls on the island were measured directly using a 100m tape measure. The total area of natural habitat was estimated by multiplying the length of the habitat by its mean width, the latter derived from measures of width along the transect lines. Not all of the habitat within a sub colony is suitable as nesting habitat for Storm Petrels and so at 1m intervals along each transect the habitat was scored as suitable or not suitable. This measure was used to calculate the percentage of nesting habitat in each sub colony and the total area within the perimeter boundary was corrected using this percentage to give an estimate of the total area of nesting habitat.

Estimation of the population

The densities of AOSs in the 100m stretches of walls and in transects within natural habitat were calculated. Analyses were conducted within these habitat types as the units of measure differed (walls: AOS/m, natural habitats: AOS/m^2). Inspection of the frequency distribution of AOS's revealed that the data were strongly skewed towards low values, suggesting that AOS distribution was clumped, so the arithmetic calculation of means and confidence intervals was inappropriate as this assumes a normal distribution. Instead, a bootstrapping procedure was used to resample the density data and produce a frequency distribution of possible mean values for which the arithmetic mean and CIs could be calculated (Westfall and Young 1993). The bootstrapped mean AOS density and upper and lower 95% confidence intervals (CIs) were then extrapolated to the total length of wall or area of natural habitat.

A correction factor was applied to estimate the number of birds that were breeding but did not respond to the playback. Studies of response rates in known Storm Petrel nest sites (Ratcliffe *et al* 1997a) showed that the probability of a bird responding was 0.25 (Lower 95% CI = 0.23, Upper 95% CI = 0.27) giving a correction factor of 4 (Lower 95% CI = 3.7, Upper 95% CI = 4.3). These figures were multiplied by the estimates of detected AOSs to give an estimate of the population status and the confidence limits around this estimate. The figures for natural habitats and walls were finally summed to give an estimate of the total island population on Mousa.

Results

The census of the 10m sections of wall habitats found that the sample mean AOSs detected per metre of wall was 0.15, although the bootstrapped mean was 0.19. This difference was due to bias of the sample mean, since it is based on a small sample and the variance is quite large. The total length of walls on Mousa was 4,923m and the mean number of AOS's per metre was extrapolated by the bootstrapped mean to give an estimate of 950 detected AOS's (Table 1). Correction

factors were applied to this figure to estimate the number of birds that were present but did not respond to playback. This produced an estimate of 3,800 AOSs in wall habitats (Lower 95% CI = 2,823, Upper 95% CI = 4,592, Table 1).

In natural habitats, the sample mean density of AOSs was 0.08, which was exactly the same as the bootstrapped mean. The estimated total area of the apparently suitable natural habitat was 9,596m^2. The extrapolation of the mean detected density by the total area gave an estimate of 738 AOSs. Correcting this figure to allow for the number of sites that were undetected gives an estimated total of 2,956 AOSs in natural habitats (Lower 95% CI = 1,987, Upper 95% CI = 4,167, Table 2). These estimates of AOS abundance within habitat types can be summed to give an population estimate on Mousa of 6,759 AOSs (Lower 95% CI = 4,810, Upper 95% CI = 8,759). Rounding these figures to the nearest 100 AOSs to give a reasonable level of precision gives a final estimate of 6,800 AOSs (Lower 95% CI = 4,800, Upper 95% CI = 8,800). Further details of the locations of the habitats surveyed, the

Table 1 ***Calculation of population estimate for wall habitats.***

Parameter	Mean	Lower 95%CI	Upper 95% CI
Detected AOS density[1]	0.19	0.16	0.22
Extrapolated AOS Estimate[2]	950	763	1068
Estimated population [3]	3800	2823	4592

[1] Mean and 95% confidence intervals calulated from bootstrap estimates.
[2] Detected AOS density multiplied by the length of wall (4,923m).
[3] Estimated population after correcting for birds present but not detected. Correction factors are: Mean (^{2} x 4), Lower 95% CI (^{2} x 3.7), Upper 95% CI (^{2} x 4.3).

Table 2 ***Calculation of population estimate for natural habitats.***

Parameter	Mean	Lower 95%CI	Upper 95% CI
Detected AOS density[1]	0.08	0.06	0.10
Extrapolated AOS Estimate [2]	738	537	969
Estimated population [3]	2,956	1,987	4,167

[1] Mean and 95% confidence intervals calculated from bootstrap estimates.
[2] Detected AOS density multiplied by the total area of natural habitat (9,596m^2)
[3] Estimated population after correcting for birds present but not detected. Correction factors are: Mean (^{2} x 4), Lower 95% CI (^{2} x 3.7), Upper 95% CI (^{2} x 4.3).

raw count data and calculations of population status can be found in Ratcliffe *et al* (1997b).

In addition to the AOSs detected in the survey of the main habitats, a small number of AOSs (approximately 20) were found in the sparse outcrops of stone on the North Isle and adjacent to the Underlee sub colony. The Broch also contains a small number of birds but the exclusion of these 3 areas is unlikely to affect the population significantly given the size of the confidence intervals around it.

Discussion

The estimated 6,800 AOSs means that Mousa is of considerable national importance for breeding Storm Petrels and based on Lloyd *et al* (1991) could represent between 4% and 32% of the UK population. However, the low accuracy of the population estimates for Storm Petrels (Lloyd *et al* 1991) means the national importance of the colony at Mousa is actually difficult to interpret. A playback survey of all the colonies in Britain and Ireland would be required to fully appreciate the relative importance of Mousa, although it is undoubtedly an important breeding site for this species.

The population estimate of 4,500-5,000 AOSs from Suddaby (1992) approximates to the lower 95% confidence interval (4, 800) from this survey and this perhaps suggests that the population is stable or increasing. However, the distribution within Mousa may have changed substantially. The 1992 estimate for the Broch boulder beach was higher than the 1996 estimate (1992 = 1,300, 1996 = 300) but that for the walls was lower than 1996 (1992 = 2,300, 1996 = 3,800). Suddaby only surveyed the walls and the Broch boulder beach as nocturnal visits and located 'very few' calling birds in other areas of natural habitat, so there may have been a decline in numbers in the Broch boulder beach and an increase in the walls and other natural sites.

These possible trends should be treated with caution as the methods used differed greatly between the surveys. In 1992, Suddaby used nocturnal visits to map densities of calling birds without playback. The Broch boulder beach and lengths of wall were surveyed for purring males from early July through to late August. A correction factor of 2.65 was used to estimate the number of sites missed due to them not containing a calling male and extrapolations to total wall length and beach area were made. However, the survey was timed when most birds on Mousa would be incubating eggs or have chicks (Bolton unpublished data, Ratcliffe *et al* 1997a). Breeding males purr primarily during the pre egg stage (Scott 1970) and purring decreases greatly after eggs are laid (Scott 1970, Ratcliffe *et al* 1996). Non breeding birds appear in colonies during July and August at night in large numbers and males regularly purr from potential nest sites (Scott 1970). It is therefore possible that many of the birds detected during the 1992 census were in fact non breeders.

Non breeding birds are unlikely to cause a significant bias in the 1996 census results. Data on diurnal attendance and response rates of non breeding Storm Petrels at Mousa in 1996 suggest that the probability of detecting a non breeding bird during a single survey is less than 0.005 (Ratcliffe *et al* 1997a) and so will not comprise a significant proportion of the sites detected.

It is important that further surveys are conducted on Mousa to estimate the population trends for this important population. There are few data on the trends of Storm

Petrels due to the difficulty in obtaining comparable estimates. An improved understanding of the status and trends of populations at Mousa and other main colonies in the UK is essential for the implementation of appropriate conservation action to conserve this species.

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Fish prey in the diet of Great Skuas at St Kilda

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Fish prey in the diet of Great Skuas at St Kilda was investigated during the 1994-1996 breeding seasons through the analysis of sagittal otoliths collected from regurgitated pellets. A total of 1054 otoliths was collected from breeding territories, the vast majority being Poor Cod/Norway Pout with fewer Whiting and Haddock. The diet of non breeding skuas was assessed by collection of otoliths from the one club site. Of 1224 otoliths, most were from Poor Cod/Norway Pout and Whiting. Fish were probably scavenged from fishing boats. There were few Sandeels in the diet and these never exceeded 2% of otoliths collected from any site or year. Several species of fish recorded in this study can be described as meso or bathypelagic and have not previously been recorded in the diet of Great Skuas.

Introduction

The Great Skua *Catharacta skua* colony at St Kilda was founded in 1963 when a single pair was confirmed breeding on the main island of Hirta (Pollock 1963). Since then, the colony has grown to 213 occupied territories in 1996 (see Phillips *et al* 1997a). A recent study, based on regurgitated pellet analysis, revealed that the diet of Great Skuas at St Kilda consisted mainly of other seabirds, with Goose Barnacle *Lepas anatifera* and fish of lesser importance (Phillips *et al* 1997b). Furthermore and perhaps surprisingly, of fish species found in the diet in that study, Sandeel *Ammodytes sp*, was rarely recorded at St Kilda (Phillips *et al* 1997b). However, Sandeel is thought to be an important prey species for Great Skuas at some of its other breeding sites in Scotland (for example, Furness & Hislop 1981, Hamer et *al* 1991). In this paper we present a comprehensive summary of the fish species recorded in the diet of Great Skuas at Hirta, St Kilda during the breeding seasons of 1994-96.

Methods

The St Kilda archipelago (57°49'N 08°35'W) consists of 4 main islands (Hirta, Dun, Soay and Boreray) with numerous sea stacs. The work for this study was carried out on Hirta during the 1994, 1995 and 1996 breeding seasons. Great Skuas regurgitate the indigestible remains of food in the form of a pellet. In the vast majority of cases, pellets contained the remains of only one prey type (bird, fish, Goose Barnacle, other crustacean or Squid). Those derived from fish (containing vertebrae and other bone fragments) were examined for the presence of sagittal otoliths ('ear bones') which were collected and later

identified to species wherever possible, using comparative reference material and Härkönen (1986). Pellets were collected from breeding territories and the only club site (a well defined area frequented primarily by non breeding Great Skuas throughout the breeding season (Klomp & Furness 1990)) between late May and early August 1994-96, with the majority collected during chick rearing. Pellets found at the club site were produced mainly by non breeders, but not exclusively so, as breeding adults regularly bathed in the nearby lochan and used the adjacent club site for preening. Fresh pellets only were collected.

Results and discussion

Use of otoliths from pellets

Many studies have analysed prey remains in regurgitated pellets to assess seabird diet (for example, Barrett & Furness 1990, Hamer *et al* 1991, Harris & Wanless 1991, Mund & Miller 1995). In the case of Great Skuas, this approach has notable advantages; it is non invasive and a large amount of dietary information can be gathered relatively easily. In contrast, direct observations of prey regurgitated by adult males for their partners or by adults for their chicks at the territory can be difficult; it is often impossible to identify prey to species level when observed from distance, and the amount of dietary information obtained (number of birds studied, number of prey identified) is likely to be less.

However, pellet analysis has inherent drawbacks and limitations. For example, pellets will persist for differing time periods after production depending on their composition (Furness & Hislop 1981), potentially adding bias towards more resilient pellets. Perhaps most importantly, studies of captive Shags *Phalacrocorax aristotelis* have shown that otolith recovery in regurgitated pellets depends upon the species of fish and the size of otoliths consumed (Johnstone et *al* 1990). In that study, smaller, more delicate otoliths (from Sandeel and Sprat *Sprattus sprattus)* were recovered to a lesser extent than larger, more robust otoliths (from Cod *Gadus morhua).* Furthermore, due to acid digestion smaller otoliths were found to be eroded to a greater extent than larger otoliths, making calculations of fish size based on regurgitated otolith size prone to error (Johnstone *et al* 1990). This finding agreed with acid digestion trials using extracted otoliths, in which Herring *Clupea harengus* otoliths dissolved at a faster rate than those from Haddock *Melanogrammus aeglefinus* (Jobling & Breiby 1986). It is clear therefore, that otoliths from small fish species or juvenile fish may be underestimated in pellet collections, at least in Shags, and that calculations of fish size based on regurgitated otoliths can be inaccurate.

In the present assessment and for the reasons outlined above, we have not attempted to calculate fish size from regurgitated otoliths but we did detect otoliths of small or juvenile fish, most notably of Whiting *Merlangius merlangus* and Blue Whiting *Micromesistius poutassou.* Other studies of Great Skua diet have found pellets containing otoliths from small fish species, predominantly Sandeel, often at high frequencies (for example, Furness 1979, Furness & Hislop 1981, Baber 1992). It is unlikely, therefore, that small or juvenile fish would be completely overlooked in regurgitated pellets, but it is possible that their relative abundance in Great Skua diet assessed through otoliths, would be underestimated. Despite this potential drawback, analysis of regurgitated pellets is the most efficient method of gaining an overview of fish in the diet of Great Skuas.

Species recorded

Fish species recorded in Great Skua pellets from breeding territories are presented in Table 1. Of 1054 otoliths recovered over the 3 breeding seasons, the vast majority (56-86%) were of Poor Cod *Trisopterus minutus* or Norway Pout *T. esmarki*. Whilst for relatively intact and large otoliths of Poor Cod and Norway Pout separation to species is possible, this becomes extremely difficult using worn, fragmented and small otoliths. For this reason we have combined these 2 species into a single group. Of the other species recorded, only Whiting and Haddock represented more than 10% of otoliths (Table 1). These species have been recorded frequently in the diet of Great Skuas at other Scottish sites (Furness 1979, Furness & Hislop 1981, Hamer *et al* 1991). Similarly, otoliths recorded at the club site showed a predominance of poor Cod/ Norway Pout (52-85%) and Whiting (up to 15%; Table 2). All other species were relatively infrequent. Included in this last category was Sandeel, which represented less than 2% of otoliths collected and which was absent from all collections in 1996.

By comparison with other sites in Scotland, the paucity of Sandeel recorded in the present study (Tables 1 & 2) is striking. Other seabird species (notably auks) at St Kilda are known

Table 1 ***Numbers and percentages of otoliths of different fish species from pellets regurgitated by Great Skuas from breeding territories at Hirta, St Kilda.***

Fish species	1994		1995		1996	
Poor Cod *Trisopterus minutus*/ Norway Pout *T. esmarki*	318	85.5%	250	81.2%	211	56.1%
Bib *T. luscus*	8	2.2%	12	3.9%	2	0.5%
Whiting *Merlangius merlangus*	14	3.8%	28	9.1%	83	22.1%
Haddock *Melanogrammus aeglefinus*	10	2.7%	-	-	46	12.2%
Saithe *Pollachius virens*	2	0.5%	-	-	12	3.2%
Sandeel *Ammodytes* sp.	6	1.6%	4	1.3%	-	-
Scad *Trachurus trachurus*	7	1.9%	-	-	-	-
Blue Whiting *Micromesistius poutassou*	-	-	-	-	9	2.4%
Unidentified gadids	3	0.8%	2	0.6%	9	2.4%
Herring *Clupea harengus*	2	0.5%	4	1.3%	-	-
Silvery Pout *Gadiculus argenteus*	-	-	-	-	1	0.3%
Argentine *Argentina sphyraena*	-	-	4	1.3%	-	-
Lepidion eques	-	-	-	-	1	0.3%
Tadpole fish *Raniceps raninus*	-	-	2	0.6%	-	-
Forkbeard *Phycis blennoides*	2	0.5%	-	-	2	0.5%

Table 2 ***Numbers and percentages of otoliths of different fish species from pellets regurgitated by Great Skuas from the club site at Hirta, St Kilda.***

Fish species	1994		1995		1996	
Poor Cod *Trisopterus minutus*/ Norway Pout *T. esmarki*	453	84.5%	457	80.5%	66	51.6%
Bib *T. luscus*	17	3.2%	12	2.1%	-	-
Whiting *Merlangius merlangus*	28	5.2%	60	10.6%	19	14.8%
Haddock *Melanogrammus aeglefinus*	5	0.9%	9	1.6%	2	1.6%
Saithe *Pollachius virens*	4	0.7%	17	3.0%	9	7.0%
Sandeel *Ammodytes* sp.	8	1.5%	-	-	-	-
Scad *Trachurus trachurus*	1	0.2%	4	0.7%	-	-
Blue Whiting *Micromesistius poutassou*	-	-	-	-	12	9.4%
Unidentified gadids	3	0.6%	-	-	3	2.3%
Silvery Pout *Gadiculus argenteus*	6	1.1%	-	-	16	12.5%
Argentine *Argentina sphyraena*	6	1.1%	1	0.2%	-	-
Lepidion eques	2	0.4%	2	0.4%	-	-
Tadpole fish *Raniceps raninus*	1	0.2%	-	-	-	-
Blackspot Grenadier *Coelorhynchus coelorhynchus*	-	-	-	-	1	0.8%

to feed on Sandeels (Harris 1984, Leaper *et al* 1988), but it may well be that they are unavailable to Great Skuas except through kleptoparasitism. Furthermore, regurgitations by Great Skua chicks did not contain any Sandeel in 1996 (Phillips et al 1997b), nor were Sandeel recorded in either adult or chick regurgitated food in 1997 (S Bearhop *pers comm*). This lack is particularly interesting given the dramatic effect the reduction of Sandeel availability at Shetland had upon the breeding success of Great Skuas at Foula (Hamer *et al* 1991). Furness & Hislop (1981) noted that Sandeels were fed to Great Skua chicks at Foula in preference to whitefish or other foods. Furthermore, Hamer *et al* (1991) described poor chick growth, a decrease in the attendance of adults at the colony and poor breeding success in Great Skuas at Foula in association with a reduction in the availability of Sandeels. In response to this adult skuas fed to an increased extent upon seabirds and spent more time foraging (Hamer *et al* 991). That the Great Skuas at St Kilda appear to breed as successfully as at sites where Sandeel is thought to be an important prey (Phillips *et al* 1997b) is particularly noteworthy.

The majority of the fish species recorded are likely to be derived from commercial fishing operations near to St Kilda. Trawling and long line fishing activity have been noted over the continental shelf edge, to the west of St Kilda (Leaper *et al* 1988, *pers obs*). With few exceptions, these fish can be considered mid water or bottom dwelling species (Whitehead *et al* 1989), and, therefore, most likely made available to skuas through discarding. Noteworthy in this category are Silvery Pout *Gadiculus argenteus, Lepidion eques* and Blackspot Grenadier *Coelorhynchus coelorhynchus* which are either bathypelagic or benthopelagic, occurring at depths generally greater than 200m and often in excess of 1000m (Whitehead *et al* 1989). Deep water fish have been recorded in the diet of seabirds previously (for example, Imber 1973, Hamer *et al* 1994, Thompson *et al* 1995), but to our knowledge this is the first time that meso and bathy pelagic fish have featured in the diet of Great Skuas.

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Great Skua chasing tern *Barry Larking*

SHORT NOTES

Common Buzzards cartwheeling during a food pass

Aerial activity in early spring between Buzzards *Buteo buteo* usually consists of soaring and diving displays between pairs but contact between birds is rare beyond touching of wings (Cramp & Simmons 1980, *Birds of the Western Palearctic*, Vol 2, Oxford). Buzzards will turn over and present talons in courtship and an extension of this behaviour occurred on 27 March 1996 when 2 Buzzards circled each other over moorland near Newton Stewart, Wigtownshire. The male had a reptile, either an Adder *Vipera berus* or a Slow Worm *Anguis fragilis* dangling from his talons above the female. The female tried to collect the prey by a food pass and 3 times turned over on her back trying to take the prey, talon to talon, uttering calls. On the fourth attempt they locked talons and cartwheeled several times. The reptile dropped, the female unlocked her talons and deftly caught the prey. She glided down to some trees followed by the male.

The only other documented records of talon locking appear to be of a Red-shouldered Hawk *Buteo lineatus* which engaged in talon locking and cartwheeling when it attacked a conspecific in its breeding area in North America (Johnsgard 1990, *Hawks, Eagles and Falcons of North America*, London).

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Buzzard *Jim Young*

Cannibalism in a Merlin brood

Relations among siblings in broods of falcons are usually peaceful and deliberate fratricide is unknown (Cade 1982, *The Falcons of the World*, London). As there is no apparent aggression among Merlin *Falco columbarius* siblings, cannibalism is also rare and evidence of it hard to obtain.

The only direct evidence of cannibalism obtained during long term studies in Galloway was on 18 July 1976 when I made a routine visit to a Merlin's nest on a heathery ledge deep in dense conifer plantations. The nest contained 2 fully feathered young about 23-25 days old and one dead young which was lying on its back. It was obvious that I had just disturbed the 2 live siblings eating their dead sibling because they were standing over it with their beaks freshly blooded and the breast freshly plucked. The dead sibling could have died naturally as there was no visible injuries, but Adder *Vipera berus* predation could not be ruled out as an Adder was lying sunning just below the nest site (see also Shaw 1994, *Scottish Birds* 17:162). Fresh prey remains at the nest site included a Skylark *Alauda arvensis*, 2 Meadow Pipits *Anthus pratensis*, and 2 Chaffinches *Fringella coelebs*. The 2 young eventually fledged.

The only other evidence of cannibalism in a Merlin brood is that given by Brown (1976, *British Birds of Prey*, London), who gave details from ringing returns of 3 dead young in a nest where one had apparently been eaten by its nest mates. Cade considered it likely that in severely food stressed broods of falcons a chick that dies will be eaten by its siblings, although starvation did not seem to be the cause at the nest in Galloway.

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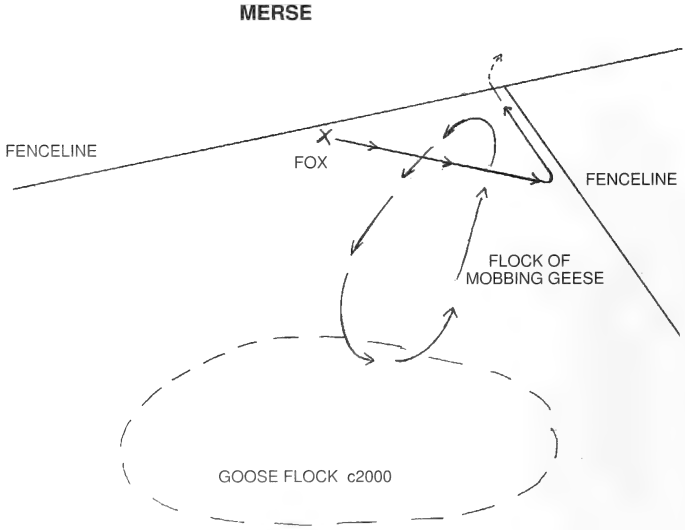
Merlin *Andrew Stevenson*

Mobbing behaviour by Barnacle Geese on a ground predator

On 19 March 1996 at Caerlaverock WWT Reserve, Dumfries & Galloway, I was observing a flock of around 2000 Barnacle Geese *Branta leucopsis* which were feeding on improved pasture. Suddenly, all the birds appeared very alert and uneasy. After about 5 minutes of vigilance by the goose flock a single Red Fox *Vulpes vulpes* appeared from the corner of the field and began walking very slowly towards the fence line bordering the neighbouring field (see diagram).

About 300 geese immediately took flight from the main flock and flew directly over the fox at a height of about 20m from the ground. These birds were continually calling. The flying geese then circled back over the remaining flock on the ground but did not land to rejoin them. Instead, they flew back over the fox at the same height, calling constantly. Some birds even tried to hover over the mammal. This mobbing behaviour, which lasted a total of 3 minutes, was repeated 5 times in succession over the fox. It only stopped when the creature had reached the fence line of the neighbouring field. During



the mobbing some of the birds returned to the vigilant flock on the ground and at the last (fifth) mobbing attempt there were only around 200 birds left in the air. When the flying geese were mobbing the fox, the remaining geese on the ground were vigilant and calling constantly.

I have been working on Barnacle Geese for 3 years at Caerlaverock and this is the first time that I have witnessed geese taking any attacking action against a ground predator. The usual behavioural action taken by Barnacle Geese towards a fox at Caerlaverock is simply the alert posture, although sometimes birds will walk towards and almost follow a fox until it is out of sight. This observation of geese acting as a flock when mobbing, and also defending, compares with other observations on Barnacle Geese seen at Caerlaverock in response to the presence of a Peregrine Falcon *Falco peregrinus*. (Patterson, *Scottish Birds* 18:101-102). However I can find no reference to Barnacle Geese mobbing a ground predator.

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Accepted March 1997

Barnacle Geese *Rodney Dawson*

Marsh Warblers breeding in Orkney in 1993: a first for Scotland

On 14 July 1993, one of us (RGA) visited an area of reed swamp *Phragmites australis* in order to clear rides for mist netting As the work progressed, a single net was erected and an *Acrocephalus* warbler was caught. It was identified as a Marsh Warbler *A. palustris* on the basis of its general colouration and wing formula (Svensson L 1992, *Identification guide to European Passerines, 4th edition* Stockholm). The bird was judged to be an adult and, as June is the normal month for the spring passage of this species in the northern isles, it was presumed to be a lingering migrant. However, on 20 July, a second adult bird was trapped by RGA while the first was retrapped. The second bird was also identified as an adult Marsh Warbler although the wing formula was not as clear cut as on the first bird.

On 22 July one of these birds was watched by RGA on 6 occasions as it carried large beakfulls of food and also called in a very agitated manner; a second bird was seen very briefly. RGA contacted ERM who visited the reed bed shortly afterwards. He too saw one, probably 2, birds one of which was seen with food, called repeatedly and sang frequently. This bird only gave brief views but appeared to be a Marsh Warbler with olive toned upperparts, distinctly pale tipped inner primaries and a song with an outstanding amount of mimicry. The activities of the birds were centred on an area of the *Phragmites* bed about 30m from its boundary with improved grassland and 80m from the open water of the nearby loch. At this point, running through the reeds, was a small ditch edged with Meadow Sweet *Filipendula ulmaris*, Marsh Marigold *Caltha palustris*, Forget-me-not *Myosotis sp* and Water Mint *Mentha aquatica*. Also close to the ditch is a substantial Willow *Salix sp* bush from which the bird did most of its vocalising. On 24 July one of the ringed birds was again glimpsed by RGA and also heard and seen briefly by T R Dean who also considered it to be a Marsh Warbler.

Thereafter, windier weather conditions made watching in the reed bed very difficult so that no further observations were made. On 11 August, RGA was mist netting for Sedge Warblers *Acrocephalus schoenobaenus* when he caught 2 unstreaked *Acrocephalus* warblers. The freshness of the plumage indicated that these were both immature birds while the lack of rufous in the upper parts and the length of the 2nd primary notch strongly suggested that they were Marsh rather than Reed Warblers *A.scirpaceus* (Svensson 1992). On 16 August, a third immature bird was caught and ringed by RGA and similarly considered to show characters of Marsh rather than Reed. None of the 5 birds was seen again after this date. The whole scenario suggested that a pair of Marsh Warblers had successfully fledged 3 young.

In an attempt to verify the records ERM and Martin Gray independently examined the wing formula data for the 5 birds. The data were graphed using the methods described in (Walinder G , Karlsson L & Persson K 1988 A new method for separating Marsh Warblers from Reed Warblers *Ringing & Migration* 9:55-62.). Using these methods the first adult was conclusively identified as Marsh Warbler but the second adult fell in the Marsh/ Reed overlap zone (Adam & Meek, 1994). The 3 immature birds were considered next. Using one of Walinder's graphing methods (wing length v notch length) all 3 fell just within the range of Marsh. However, using his other method (wing length v notch position)

produced a different picture with 2 birds falling within the range of Reed and the other falling close to the overlap zone. One explanation of these discrepancies between the 2 methods was, of course, that the immature birds, especially those measured on 11 August, did not have fully developed wings when trapped. Notch length is fixed once the feather has emerged from pin but its position in relation to the other primaries is not set until the feather has completed growth.

Because of the discrepancies we felt that it was not possible to claim, as certain, a first breeding record for Scotland although the evidence did strongly suggest this to be the case. A paper in the *Orkney Bird Report* 1993: 73-76, Did Marsh Warblers *Acrocephalus palustris* breed in Orkney in 1993? Adam R G & Meek E R 1994, reported this situation and the details were repeated in the report on *Rare breeding birds in the United Kingdom in 1993, British Birds* 89:2:87.

Subsequently ERM and RGA were contacted by JH of Westphalia, Germany who has been working on the Marsh Warbler population of that area and who had developed an interest in the birds of Orkney on holiday in the islands in 1992. He confirmed that the description of the breeding territory fitted perfectly with the habitat utilised in Westphalia. Turning to the morphometric data, rather than the Walinder method, he applied the methods described in H Dorsch (1983 Bewertung verschiedener Merkmale zur sicheren Unterscheidung von Teichund Sumpfrohrsanger *(Acrocephalus scirpaceus, A.palustris)* mit einer praktischen Bestimmungshilfe *Ber. Vogelwarte Hiddensee* H.4: 111-120.) to the published data in the *Orkney Bird Report*. Using this method, the first adult and all 3 of the immature birds were clearly Marsh Warblers; only the second adult could not be certainly identified as Marsh. However, because the second adult was also identified as Marsh on general colouration and because the Walinder method placed it in the overlap zone and not in the Reed Warbler zone (see graphs in Adam & Meek, 1994), we are now confident that a pair of Marsh Warblers did indeed breed successfully in Orkney in 1993 and that this represents the first breeding record of the species in Scotland (Thom V M 1986 *Birds in Scotland* Poyser, Calton). The birds did not return to the site ialthough a pair did breed successfully at a site 15km to the south in 1997.

Acknowledgements

We are especially grateful to Jörg Hadasch for his interest in this record and for his efforts in helping us to establish its validity. We also thank Martin Gray for his independent examination of the wing formula data.

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Revised manuscript accepted April 1997

An unusually open Wigeon nest

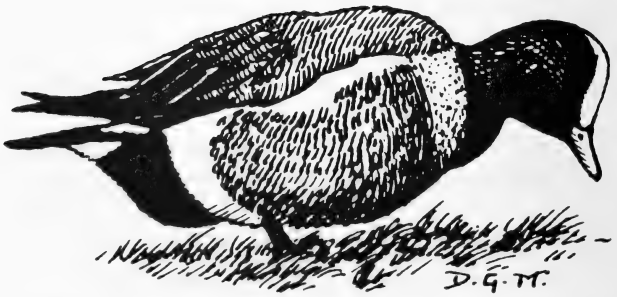
At 0800 on 23 June 1996 near Ballater, Deeside we noticed a female Wigeon *Anas penelope* lying very flat and still in short grass approximately 10m from a small roadside pool. She was still in this position when we left 10 minutes later. In the evening we were surprised to see the female Wigeon still in the same place, again lying very low and still. SF began to walk towards the sitting bird 30metres away. She quickly flushed and flew away. To our amazement she had been sitting on a nest which contained 5 eggs.

The grass was no longer than a couple of centimetres with grazing cattle present in the field. The pool, which was approximately 20x8m and drying out fast, was in the centre of the field and 30m from any cover. Although the Wigeon had made her nest in a slight hollow, the surrounding grass was so short that even when lying flat the top half of her body was visible. Wigeon nests are normally well hidden in vegetation. Of 16 nests found during a Wigeon study at another site in Deeside, all were fairly well hidden amongst Heather *Calluna vulgaris*, Rushes *Juncus* sp or rank grass.

The Ballater nest was visited again on 29 June when it was found to contain 4 eggs. The female was still sitting on 9 July but there was no sign of her on 14 July when the nest contained 3 eggshells, from which chicks appeared to have successfully hatched, and an infertile egg. The laying date, when calculated back from the approximate date of hatching, and the clutch size suggested this was probably a repeat clutch.

Raymond Duncan, 86 Broadfold Drive, Bridge of Don, Aberdeen
Simon Foster, 17 Malcom Canmore, Tain, Ross-shire

Accepted May 1997



Drake Wigeon *David Mitchell*

Song Thrush apparently nesting on the ground

On 12 April 1997, a member of the Royal Dornoch Golf Club informed me that on 2 recent occasions he had flushed a Song Thrush *Turdus philomelos* from 2 eggs on a bare patch on the ground below Gorse *Ulex europaeus* bordering one of the golf course fairways. Visiting the site later that day, I found that it had been predated and all that remained were several pieces of Song Thrush eggshells, which lay on a piece of bare ground below the overhanging Gorse. An inspection of the cover overhead failed to reveal any sign of a nest from which the eggs might have fallen out. *BWP* Vol 5:998 describes various Song Thrush nest sites ending with the words, 'and on the ground among thick vegetation' which, I assume, refers to a normally constructed nest.

D Macdonald, Elmbank, Dornoch, Sutherland IV25 3SN

Accepted May 1997

Song Thrush *Andrew Dowell*

Hunting times of Sparrowhawks in the non breeding season

During studies of the hunting times of Merlins *Falco columbarius* and Hen Harriers *Circus cyaneus* (*Scottish Birds* 17:56-58, 18:182-183) in winter in west Galloway, I also saw Sparrowhawks *Accipiter nisus* (adults and juveniles) hunting regularly in the same open country habitats between August and February 1970-97. Each year all hunts were timed in open country only, where I spent an equal amount of time at different hours of the day (see Dickson 1992, *The Birds in Wigtownshire*, Wigtown for details of sightings in various habitats).

Two hundred and fifteen hunts were recorded by both classes: 131 by adults, 84 by juveniles (first years). Sixty nine percent of adult hunts

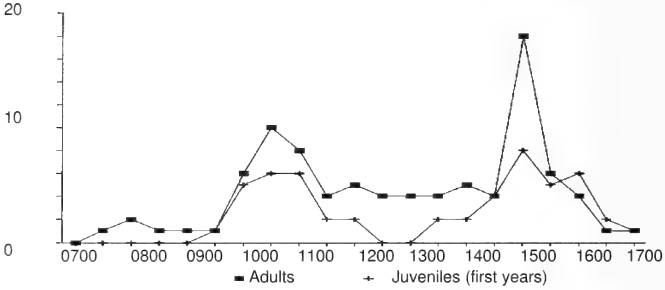


Figure 1 ***Hunting times of Sparrowhawks in west Galloway, November - February 1970-97***

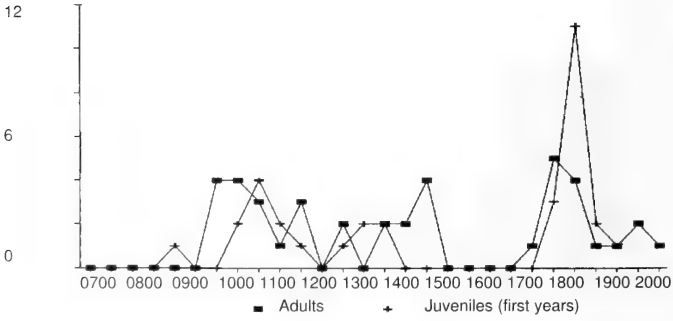


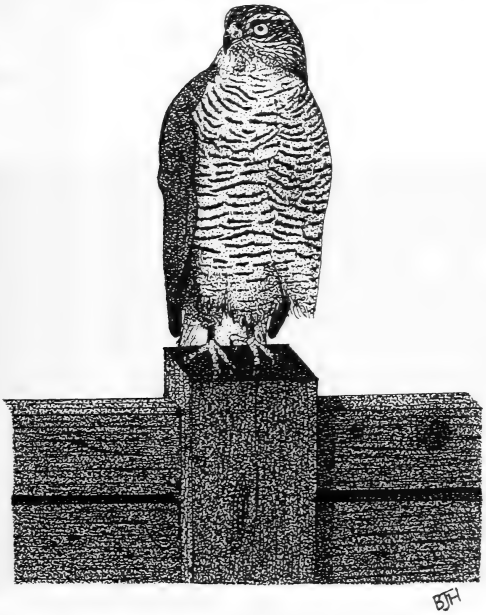
Figure 2 ***Hunting times of Sparrowhawks in west Galloway, August - October 1970-97***

occurred in the period November-February (Fig 1) and 31% in August-October (Fig 2); 62% of juvenile hunts were in November-February (Fig 1) and 38% in August-October (Fig 2). Both classes showed pronounced peaks of activity at 1030 and 1500 hours in the period November-February. In the period August-October there was no pronounced peak of activity during the day by both classes but there was a definite peak by juveniles at 1830 hours (BST).

The findings in this study of major peaks of activity in mornings and afternoons with lulls in activity around midday agree with the findings on the hunting times of other raptors in winter. The main peaks in Figure 1 by juveniles coincide with the winter peaks described by Newton (1986, *The Sparrowhawk,* Calton), but the more pronounced peak of activity in the afternoon shown by adults in Figure 1 was not recorded by Newton.

R C Dickson, Lismore, New Luce, Newton Stewart, Wigtownshire DG8 0AJ

Revised manuscript accepted June 1997



Sparrowhawk *Brent Hurley*

Merlin's sunning behaviour in winter

Sunning behaviour by Merlins *Falco columbarius* in winter has rarely been observed in the wild. In a list of species recorded sunning, Merlins were not mentioned (Kennedy 1969, *British Birds* 62:249-258) although sunning was subsequently recorded (in summer?) in the North American subspecies (Cade 1982, *The Falcons of the World*, London). Informaton on sunning behaviour by wild Merlins in winter in Britain is thus generally lacking and probably under recorded.

On 19 January 1997 at 1105 GMT, a relatively mild, cloudless day (9^{0}C) with warm sun and very light winds, I watched a female or juvenile Merlin preening vigorously on a fence post on low ground in Wigtownshire. After preening it stood, back to the sun, with its wings held partly down and extended in the typical ' loose spread sun basking posture' (see Simmons 1986, *The Sunning Behaviour of Birds*, Bristol). Eleven minutes later it stood with only its right wing partly extended sun basking before flying 5-7m to another fence post. Here it stood for the next 4 minutes sun basking in the loose spread posture before flying away.

Feather care used by Merlins in winter include preening, shaking and wing stretching. Cade considered that this loose spread posture is the typical sunning posture of falcons and likely to be shown by all species, although not previously documented in the wild by Merlins in mid winter.

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Hen Merlin *Arthur Gilpin*

Territory sizes of Crested Tits at Abernethy Forest, Strathspey

The Scottish Crested Tit *Parus cristatus scoticus* is confined to the Highlands of Scotland where it inhabits native pinewoods and old plantations, composed largely of Scots Pine *Pinus sylvestris* (Cook 1982, Breeding status of the Crested Tit. *Scottish Birds* 12:97-106). It is an amber rated species in the list of species of conservation concern in the United Kingdom (Gibbons *et al* 1996, Bird species of conservation concern in the United Kingdom, Channel Islands and the Isle of Man: revising the Red Data List. *RSPB Conservation Review* 10:7-18). Elsewhere in its range, the Crested Tit has been the subject of detailed studies of individual birds (eg Ekman 1979, Coherence, composition and territories of winter social groups of the Willow Tit and Crested Tit. *Ornis Scandinavica* 10:56-68) but there has been little work in Scotland where the Crested Tit is generally regarded as being sedentary (Cramp & Perrins 1993, *Birds of the Western Palearctic*, Vol 7, Oxford). However, there have been few direct observations made of individual birds to confirm this. This note provides some detailed observations on a small group of birds.

The study was carried out around Forest Lodge (57°14'N, 3°37'W) in Abernethy Forest where 6 adult Crested Tits were colour ringed with unique combinations. The study area comprised *c.*300ha of native pinewood and Scots Pine plantation, and set routes were

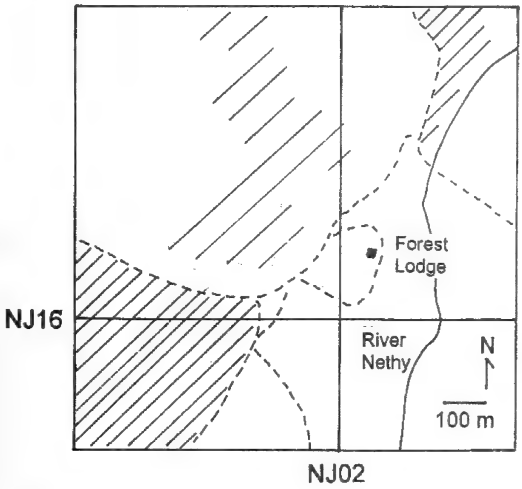

Figure 1 ***The study area at Forest Lodge. The habitat is native pinewood apart from young (heavy shading) and old plantations (light shading). Dashed lines are roads. Grid reference numbers are shown.***

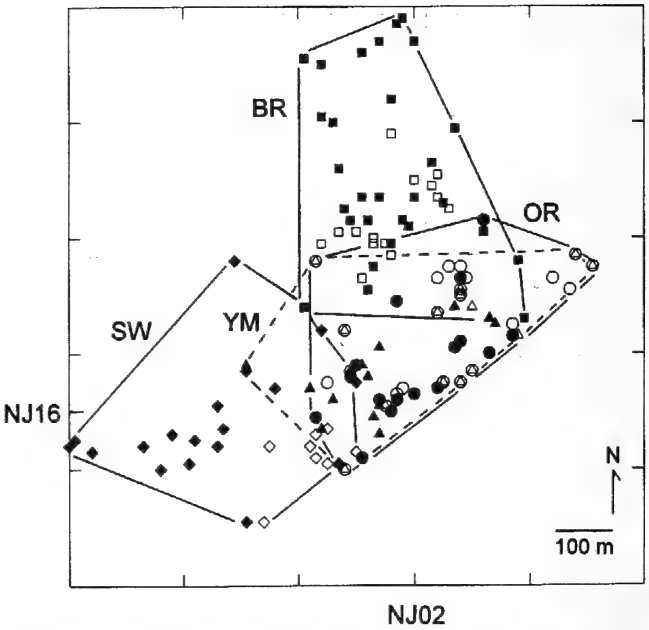

Figure 2 ***The locations of 4 Crested Tits in summer (open symbols) and winter (filled symbols). OR and YM were paired.***

walked during summer (24 May 1994-11 July 1994) and the following winter (2 November 1994-9 February 1995) to search for the marked birds (Fig 1). Once located, their positions were mapped to the nearest 10m. Observations one day apart were treated as independent of others and territories measured by joining the outermost points and measuring the size of the enclosed area (minimum area method; Mohr in Southwood 1966. *Ecological Methods*, Methuen). Because one requires a minimum of about 25 plots to estimate territory size, data for the 2 seasons had to be combined and, even then, this provided sufficient data for only 4 birds. Their territory sizes were (12.5, 13.1, 14.0 and 15.1ha (mean = 13.7ha). Birds OR and YM were a pair and had similar sized (12.5 and 13.1ha) and overlapping ranges (Fig 2). The territories of 2 neighbouring birds of this pair overlapped considerably, showing that territories were not mutually exclusive.

There appeared to be changes in the sizes of territories between summer and winter but the results were not consistent, and insufficient observations were made of most birds to give realistic estimates of territories in each season. The pair (OR and YM), had smaller ranges in winter (7.1ha, n=17 and 6.8ha, n=18) compared with summer (10.4ha, n=24 and 10.3ha, n=16). In contrast, birds BR and SW had smaller ranges in summer (3.3ha, n=15 and 1.6ha, n=9) than in winter (15.1ha, n=30 and 12.6 ha, n=17).

In order to find out if there were shifts in territories between summer and winter, the centre of each territory of all 6 birds was determined for the 2 seasons separately and the distances apart were measured. These shifts in centres were only 146m apart on average (range 81-256m). These distances were small in relation to overall territory size, indicating that these Crested Tits had fixed territories. The results of this limited study confirm that Crested Tits are sedentary, at least in a native pinewood in Scotland.

Territory sizes of Crested Tits in other situations are likely to be different. The average size of 21 group territories in Swedish forests of Norway Spruce *Picea abies*, and Birch *Betula* spp. was 20ha (Ekman 1979). Other tit species tend to have smaller territories, though there is much variation depending on habitat and breeding density. For example, Great Tits *Parus major* have territories which range in size from 0.2 to 4ha (Gosler 1993, *The Great Tit*. Hamlyn).

The birds were trapped and ringed by R Proctor and observations were made by M Adams, P Benstead, R Denny and C Jeffs. Territories were calculated by Dr M McGrady. The draft was commented on by Drs M I Avery and I P Bainbridge.

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Accepted July 1997

Crested Tit *Steven Brown*

Baby Stoat in Peregrine nest

On 8 June 1997 whilst ringing 2 small Peregrine *Falco peregrinus* chicks in an old Raven's *Corvus corax* nest in Strathcarron, Sutherland I was surprised to find a freshly dead Stoat *Mustela erminea* lying uneaten in the nest. It may have just been brought in by one of the adults as I had flushed the female from the nest as I approached. The Stoat was about 11cm in length from nose to tail with very short pink fur and looked as though it was still blind. It had obviously still been totally dependent on its parents. There were no other prey remains in the nest, apart from some feathers from a Grouse *Lagopus* sp and a Starling *Sturnus vulgaris*. Although this bird had laid 4 eggs there were only 2 chicks, one noticeably smaller than the other. Both also had empty crops indicating that prey may have been scarce.

Ratcliffe *(The Peregrine Falcon* 1980) states that small mammals are very occasionally taken by Peregrines as is carrion. There is also a record of a Peregrine stealing a vole (species unknown) from a Kestrel *Falco tinnunculus*. One can only speculate whether the Peregrine obtained the Stoat from an adult Stoat carrying its youngster, from another raptor or by finding it freshly dead Presumably, if avian prey is scarce, the adults will resort to more unusual prey in order to feed their hungry young.

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Accepted July 1997

Peregrine at nest *Jim Young*

Oystercatcher incubating Lapwing clutch

In 1995 at Colquhar, Leithen Water, Borders, a pair of Oystercatchers *Haematopus ostralegus* hatched a clutch of Lapwing *Vanellus vanellus* eggs, which produced 3 chicks, at least one of which survived for over 12 days (Dougall 1996, *Scottish Birds* 18:184). In 1996 at the same site a pair of Lapwings reared 3 chicks unaffected by Oystercatchers which were also present.

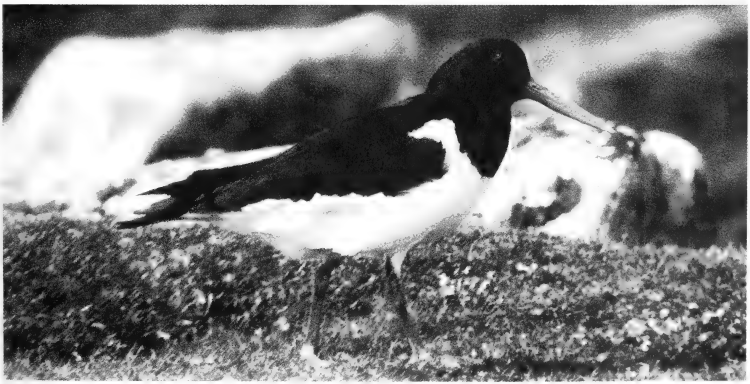
In 1997, at the same site, I again found an Oystercatcher incubating a clutch of 3 Lapwing eggs on 3 May. On 21 April I had noted 2 Oystercatchers and 2 Lapwings on site, none of which was incubating. On 26 April an Oystercatcher was seen sitting on a nest with a Lapwing standing close by. The nest was visited on 3 May, when there was no danger of trampling by sheep. On 10 May the Oystercatcher was again sitting, with its mate and one Lapwing nearby. On 18 May there were no birds on the site and the nest was not relocated, having failed for an unknown reason. It seems probable that the same (infertile?) Oystercatcher was involved in both the 1995 and 1997 events.

Oystercatchers were not seen again in 1997, but, on 31 May, 2 Lapwings were back in the area, although they were not seen to incubate on that or later dates. A single Lapwing with a brood of 2 was seen adjacent to the site on 10 and 15 June, but it is thought that this family had moved into the area from nearby.

Again, I am grateful to Mr Templeton, the Colquhar shepherd, for his tolerance of my activities.

Tom Dougall, 62 Leamington Terrace, Edinburgh EH10 4JL

Accepted August 1997



Oystercatcher *A D Johnson*

Song Thrush predation on marine gastropods

Shell fragments belonging to 4 gastropod species were collected from an 'anvil' used by a Song Thrush *Turdus philomelos* on a rocky shore in south Harris during April 1997. Of 275 shells recovered, 244 were of the Edible Periwinkle *Littorina littorea*, 28 of the Flat Periwinkle *Littorina obtusata*, 2 of the Dog Welk *Nucella lapillus* and there was a single *Littorina saxatilis*. Observations of a Song Thrush breaking shells and examination of the discarded shell fragments revealed that the gastropods were held in the beak with the spire pointing to the left and struck

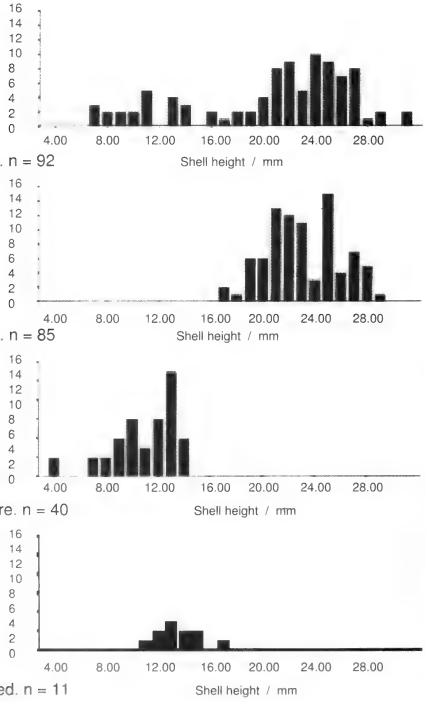


Figure 1 ***The shell heights of periwinkles*** **Littorina littorea** ***and*** **Littorina obtusata** ***found around the 'anvil' of Song Thrush and available on the shore.***

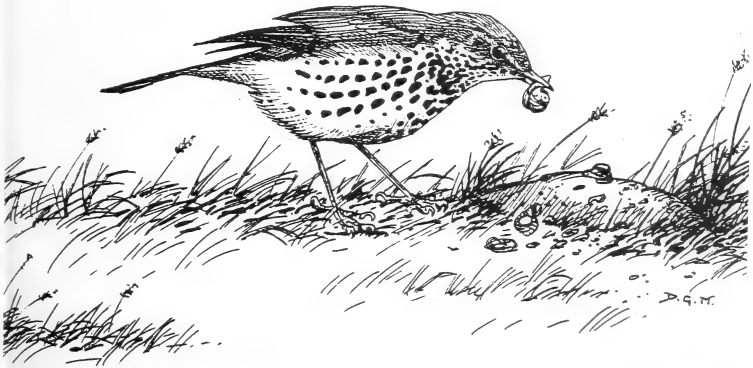
usually 3 to 4 times. The effect of this is either to break a hole in the side of the shell or to break the shell in half. Previous records suggested that such predation is largely associated with harsh weather conditions (Feare, C J 1966. *British Birds 60:412-414).* However, the quantities of shells to be found around anvils, and the regularity with which Song Thrushes were seen to behave in this way, suggests that this may not be the case in south Harris.

Maximum height was measured for the predated shells of 85 *L. littorea* and 11 *L. obtusata* that were either holed or could be pieced together from broken fragments. These were compared with the maximum shell height of 92 L. *littorea* and 40 *L. obtusata* collected from the same shore at low tide (Fig 1).

Selection of gastropods by Song Thrushes was both species and size specific. *L. obtusata* was the most numerous gastropod on the shore and *N. lapillus* was particularly conspicuous, being found on exposed rocks, yet many more *L. littorea* were taken than either of these species. The size of *L. littorea* taken in Harris corresponded to the size range of *L. littorea* in Wales that represent the adult cohort, those over approximately 4 years of age. (Williams E E 1964. The growth and distribution of *Littorina littorea* (L.) on a rocky shore in Wales. *Journal of Animal Ecology 33:413-432).* Selection of *L. obtusata* is also directed at the larger individuals in the population. Size preferences by Song Thrush presumably reflect a trade off between the amount of effort required to break the shell and the size of the gastropod obtained. Why *Nucella lapillus* are not eaten in greater numbers is not known.

Alastair Pout, Flat 2, 60 Heslington Road, York YO1 5AU

Accepted September 1997



Song Thrush *David Mitchell*

Advice to contributors

Authors should bear in mind that only a small proportion of the *Scottish Birds* readership are scientists, and should aim to present their material concisely, interestingly and clearly. Unfamiliar technical terms and symbols should be avoided wherever possible and, if deemed essential, should be explained. Supporting statistics should be kept to a minimum. All papers and short notes are accepted on the understanding that they have not been offered for publication elsewhere and that they will be subject to editing. Papers will be acknowledged on receipt and will be reviewed by at least 2 members of the editorial panel and, in most cases, also by an independent referee. They will normally be published in order of acceptance of fully revised manuscripts. The editor will be happy to advise authors on the preparation of papers.

Reference should be made to the most recent issues of ***Scottish Birds*** for guidance on style of presentation, use of capitals, form of references, etc. **Papers should be typed on one side of the paper only, double spaced and with wide margins; 2 copies are required and the author should also retain one.** We are happy to accept papers on computer discs, however, please contact Sylvia Laing on 0131 556 6042 to discuss this. Headings should not be underlined, nor typed entirely in capitals. Scientific names in italics should normally follow the first text reference to each species unless all can be incorporated into a table. Names of birds should follow the official Scottish list (*Scottish Birds* Vol 17:146-159). Only single quotation marks should be used throughout. Numbers should be written as numerals except for one and the start of sentences. Avoid hyphens except where essential eg in bird names. Dates should be written:.....on 5 August 1991.....but on the 5th (if the name of the month does not follow). Please note that papers shorter than c700 words will be treated as short notes, where all references should be incorporated into the text, and not listed at the end, as in full papers.

Tables, maps and diagrams should be designed to fit either a single column or the full page width. Tables should be self explanatory and headings should be kept as simple as possible, with footnotes used to provide extra details where necessary. Each table should be on a separate sheet. Maps and diagrams should be in black ink and be camera ready, but drawn so as to permit reduction from their original size.

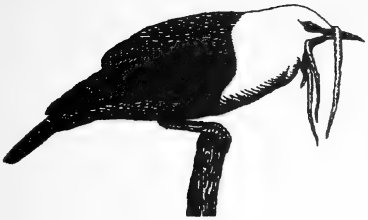
Erratum

Scottish Birds 19:2 pp105-113 Habitat use by Snow Buntings in Scotland from spring to autumn

Table1
Page 108 Flocks adults & fledglings - Beside snow should read 36^{9} and not 36.

Defective copies of *Scottish Birds*

We were disappointed to learn that some copies of the December 1997 issue had faults. So far, we know of 7; unusually the printing faults differ between each. If your copy is defective please return it and we shall send a replacement.



NEOTROPICAL BIRD CLUB

Neotropical bird club launched

A club has been launched to promote the study and conservation of the birds of the Neotropics (South America, Central America and the Caribbean). It is currently seeking founder members to help reach the launch budget of £2000, which is required to get the club running and to publish the two first issues of its intended journal 'Continga'. Founder members will be asked to pay a minimum of £25, and will be formally acknowledged in the first issue of 'Continga'. 'Continga' will provide a colourful and much needed forum for exchange of information on the avifauna of this extremely rich and diverse area, and will contain papers and features on the birds and their conservation as well as news of recent observations and discoveries (at present, new species are still being discovered at the rate of more than two a year). It is hoped that in due course the club will be able to provide direct funding and support for practical conservation programmes.

For further details and membership forms, please contact:
Rob Williams,
Publicity Officer,
Neotropical Bird Club,
c/o The Lodge,
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Scottish Birds

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Minimal numbers and habitat of breeding Dunlin in north east Scotland

R RAE & A WATSON

National surveys consider breeding Dunlin scarce in north east Scotland. We estimated at least 436 pairs on only some potential habitat. Many were on alpine land, most on moorland blanket peat, some on glen peat and dune slacks. Numbers on 4 alpine and 4 high moorland areas showed no trend in 1967-95 but on some moorland may have fallen since 1980. We saw none at 8 low level sites since 1987 after habitat loss or deterioration. Rapid methods in transects and national surveys readily overlook this skulking breeder.

Introduction and study area

Recent books (Buckland *et al* 1990; Gibbons *et al* 1993) consider breeding Dunlin *Calidris alpina* scarce in north east Scotland. Here we give a higher minimal estimate and assess habitat in the shires of Aberdeen, Kincardine and nearby parts of Angus, Perth, Banff, Moray and Inverness (Figure 1).

Methods

In 1943-86 we noted Dunlin during other fieldwork covering thousands of miles on land seldom visited by people. In 1987-97 we went specially to look for Dunlin. An egg, chick, rasping call or distraction display signified breeding and courting, nest scraping or a nest cup possible breeding.

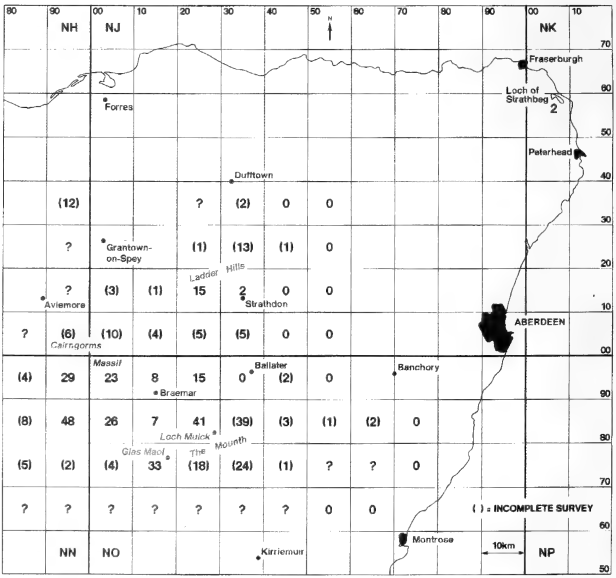
Method A involves birds with young<1 week being conspicuous on high points. On approach of a man, dog or Fox *Vulpes vulpes*, they flew from up to 100m to <10m to give distraction display, rasping calls and squeals. Method A misses birds on late nests and failed birds that have left.

Method B is to scan for the cryptic, often motionless and silent birds while walking slowly with frequent stops, zigzags and returns to previous stops. Although conspicuous when singing on calm mornings and evenings, they seldom sang on windy or warm afternoons except soon after spring arrival. Nesting birds skulked, and were easily overlooked (Campbell & Ferguson-Lees 1972).

Method C is that AW saw Dunlin adults, nests and young while counting Red Grouse *Lagopus lagopus scoticus* and Ptarmigan *Lagopus mutus* with pointing dogs (Jenkins *et al* 1963; Watson 1965). As in B, some Dunlin flushed far ahead, and were easily missed unless dogs were worked close.

Method D is to hear the dawn/dusk chorus (Watson & O'Hare 1979a & b; Watson & Rae 1987; Parr 1990). From spring arrival to having small young, Dunlin sang for c1 hour from 10-15 minutes after sunset and from >1 hour before sunrise. This can miss isolated birds; R Parr (*pers comm*) heard none at dawns near Ballater but between dawns saw

Figure 1 ***Minimum number of pairs seen in 1987-97.***
? -- potential habitat viewed from afar with binoculars
(0) -- no birds seen, apparently lacking potential habitat on farms, woods, freely drained moor and steep slopes, but only cursory inspection.
Blank squares were outside our area. Most apparently lacked potential habitat, but 4 squares south east of Forres with breeders in 1956-70 (AW) were unvisited by us since.



one on eggs. Method D requires prior daylight experience of Dunlin, walking on bogs in darkness and no strong wind or heavy rain.

The number of pairs seen in daytime searches on Glas Maol by methods A and C was similar to the number heard singing by D (Table 1). While watching Foxes, J Robertson (*pers comm*) found up to 20 pairs by method A in the 1970s at Black Burn, Loch Muick, where RR saw 10-20 pairs by A+B. Data by A+B, C and D agreed well in a Caithness study (Parr 1990). Methods A, C and D may be accurate, and B sometimes so, but need to be tested against territorial spacing (Holmes 1970). We used A, B, C and D in that frequency.

Table 1 ***Consistency within years in number of pairs seen in similar weather and date by methods A, C and D on the same area of Glas Maol.***

Year	A no dogs	C dogs	D, dawn/dusk watches
1967	6	6	-
1969	6	7	-
1970	10	10	-
1972	10	10	-
1982	6	7	7
1984	8	8	8
1986	6	7	7
1987	6	6	6
1988	6	-	6

We covered only some sites each year but assumed that each held similar numbers each year. This was valid when we visited sites in >1 year (Table 2). Of >100 sites with breeding in 1 year, all held birds when visited in a later year, bar those where there had been only 1 pair, or habitat loss.

Results

Alpine land

About 15% of pairs seen were above 800m in a) Three-leaved Rush *Juncus trifidus*, b) grass, sedge or lichen heath, and c) blanket peat (Appendix 3). Groups (territorial pairs within 150m) and isolated pairs were at 800-1100m, but above 1100m only the latter.

Most used b) and c), and a few a). Most nests on a) and b) were in tufts of rush or Mat Grass *Nardus stricta*, and some in Crowberry *Empetrum nigrum*. Some birds near paths sat tight, apparently used to people. Most nests lay near flushes, but a few were up to 400m. Birds on a) and b) nested on freely drained land, but took young to flushes, pools, lochans, or blanket peat. Flying young were on b) and c), and all Dunlin in alpine post breeding flocks of Golden Plover and Dotterel on b).

Highest nests were at 1210m on Cairn Lochan and 1230m by Wells of Dee which was a regular site in the 1930s (D Nethersole-

Table 2 ***Number of pairs seen on the same parts of 4 alpine hills in Glas Maol area and 4 high moorland ones (3 in Ladder Hills, fourth north of Ballater).***

	67	69	70	71	72	82	84	86	87	88	92	93	94	95
Glas Maol	6	7	10	6	10	7	8	7	6	6	-	-	-	-
Little Glas Maol	3	3	3	-	4	-	3	2	3	3	-	-	-	-
Cairn of Claise	2	2	3	-	-	-	-	2	3	2	-	-	-	-
Carn an Tuirc	3	3	4	-	-	-	-	-	2	3	-	-	-	-
Lecht	-	-	5	-	-	-	-	-	-	-	5	6	5	4
Carn Mor	-	-	3	-	-	-	-	-	-	-	4	3	-	4
Carn Liath	3	3	4	-	-	-	-	-	-	-	4	3	-	4
Mona Gowan	-	3	-	-	4	-	-	-	-	-	-	-	3	-

Scors Burn in Ladder Hills, 3 pairs in 1992 and 4 in 1995.

Thompson, *pers comm).* AW saw young at the Wells and others at 1150m on Feith Buidhe, and at 1140m on Garbh Uisge Beag, Lochan Buidhe, and Cnap a' Chleirich. At >1100m there was only an isolated pair in 1-2 km^2, suitable habitat being scanty.

Moorland blanket peat

Birds here formed c85% of the total seen, but we did not visit much of this habitat, so moorland may hold >90% of the population. Most were in groups (usually 3-8 pairs but up to 20). Most bred at 450-800m, the main altitude of blanket peat (Appendix 3). Some peat was uneroded, with pools and flushes on shoulders, saddles and basins. Most was eroded, with bare peat, hags, and few pools and flushes. Some of both types had meanders, oxbows and lochans.

Glen peat

This is Appendix 3's 'basin, valley and terrace peat', mostly eroded. Basin peat had vegetation like moorland peat, but several lochside and riverside mires had more sedge, less Heather and some tall rushes. In the 1930s, Loch Morlich by Aviemore held 1-2 pairs, but none after 1984 when scrub had grown (Watson *et al* 1988). In each July in 1945-47, 1-2 in alarm at Loch Davan near Dinnet probably had big young; farm stock kept plants short, but since 1960 it was ungrazed, tall sedge and scrub grew, and no Dunlin were seen since 1970. At nearby Loch Kinord, Prof D Jenkins (*pers comm*) often heard Dunlin in 1970-72 (probably 1-2 pairs), but not since. In the 1970s, 1-2 pairs bred at 300m by Dee near Braemar, but not since 1980, after high numbers of Red Deer *Cervus elaphus* overgrazed and trampled it. We saw none on Luibeg bog since 1986, after severe trampling, but they still nest on less trampled glen mires (eg Loch Tilt).

Dune slacks

At least 5 pairs formerly bred on lightly grazed slacks with pools and ditches at the Loch of Strathbeg in the late 1960s, by the late 1970s there were only 1-2 pairs, and the last known bred after 1983. After drainage in the early 1980s for more cattle and sheep, cereal was grown on one part for 2 years. In the 1990s the land began to revert to slacks and would improve with less grazing. Two pairs displayed in 1992, a pair was not displaying in 1994 and 1995, and none was seen in 1996. In late 1977 a petrochemical plant destroyed the St Fergus site, where at least 2 pairs had bred.

Main features in all sites: open water, gradient and plant height

All lay near open water, mostly alpine flushes and moorland pools. Most young were at pools, lochans, flushes, slow streams, and wet land nearby. Footprints and faeces showed much used pools. Pools used by young had shallow edges, and dried in some years such as 1994. We saw no birds at deep pools with vertical banks. Highest densities (up to 3 pairs/15 ha at 570-590m on Monaltrie Moss and 760m on the Ladder Hills) were on uneroded peat with shallow pools, flushes and nearby vegetation with much *Sphagnum.* However, density is a dubious concept where birds occur linearly on flushes or clustered at pools, and often fly to other habitats to feed.

Most were on slopes <5%, many on flats, and the few on 8-10% slopes were on flat shelves within the slope. Some in the Cairngorms bred on flats at 510m in Glen Geusachan and 860m by Loch nan Stuirteag 4km away, and not on steep land between. Another case was at 500m in Glen Derry and 850m on Moine Bhealaidh 3km away.

D Nethersole-Thompson (in Watson 1966) noted this on Speyside. All these breeding sites were on peat >2m thick, with much *Sphagnum* and many pools or flushes (Appendix 3), features absent on steep slopes due to fast drainage.

All 60 nests seen were in plants 10-20cm high, with short vegetation <10cm within 1m. We saw no Dunlin in vegetation >25cm high, and adults in <2cm were there only briefly in alarm.

Estimates of numbers

Work in 1987-97 showed at least 178 pairs breeding in 36 squares of 10 x 10km, and at least 258 possibly breeding. We searched all potential habitat in the 11 most studied squares. In 25 squares (Figure 1), not all potential habitat was visited; in only one did we visit >50%, and <25% in 21. Some unvisited land appeared from afar to be too freely drained or eroded to hold Dunlin, but the largest areas unvisited were blanket bogs with many pools in upper Feshie, Atholl-Gaick, Avon-Dorback, and northwest of Grantown. We saw some Dunlin there, but, to judge from such habitat searched more fully elsewhere, these 4 areas probably held well in excess of 100 extra pairs.

Changes in numbers between years

On 8 high areas, numbers were bigger at Glas Maol in 1970 and 1972, but changed little between decades and showed no trend (Table 2). We noticed no habitat loss or deterioration there. However, we saw no birds since 1987 on 8 low areas used by at least 15 pairs in earlier decades. Habitat was lost to industry (St Fergus) and tree planting (Abergeldie). Habitat deteriorated due to tall undergrazed plants (Lochs Davan, Kinord and Morlich), drains (Morven near Ballater), and deer overgrazing and trampling (River Dee by Braemar and Luibeg further up).

Discussion

The meaning of our current higher estimate

Appendix 1 shows big numbers and wide distribution, bar recent surveys of all species by many observers using rapid methods that readily miss Dunlin. Such surveys lack the vigilance needed to count this small cryptic bird that skulks for most of the breeding season. Also, most watchers avoid remote pathless bogs and are on the hill at 1200-1600 hours, a quiet time for Dunlin (Reed, Barrett *et al* 1983), especially in the warm sun preferred by most people. Other skulkers such as Ptarmigan and Dotterel are readily overlooked (Watson 1965; Watson & Rae 1987), and Red Grouse skulk so much that some surveys omit them (Reed *et al* 1983).

Transects for moorland birds gave densities too low and of fairly low repeatability within areas (Reed *et al* 1983), and cannot be used to calculate Dunlin density (Reed 1982). Estimates from nest finding plus ringing on 5 areas of South Uist machair on average considerably exceeded estimates on the same observers' transects, but discrepancies on individual areas ranged from 44% fewer on the transects to 50% more (Jackson & Percival 1983). With such a wide range, using the average discrepancy elsewhere would be unwise. In any case, the percentage seen on transects is likely to vary with density, season, hour, weather and whether birds have failed. A different method (point counts using supposed 'constant search effort') underestimated Dunlin densities to a varying extent on different areas (Brown & Shepherd 1993). The term 'census' is often misused in surveys of bird numbers.

Hill species cannot be counted accurately unless there is total enumeration with high repeatability. This has not been the case for breeding Dunlin, except perhaps for intensive study of individual territorial spacing as in Holmes (1970). Jackson & Percival (1983) obtained a steady cumulative total on each of 5 areas after a number of visits ranging from 5 to 13, but this is not the same as total enumeration with high repeatability on different visits.

Sharrock (1976) gave British breeding numbers as 4000-8000 pairs, and Gibbons *et al* (1993) 2 estimates of 9150 and 9900 pairs. Our data raise the UK total. Good work in Monadh Liath, Wester Ross and other peatland would raise it by thousands of pairs (cf Whitfield 1997 recently on Lewis and Harris).

Habitat

Density in Alaska was high where pools abounded (Holmes 1970). Density on the Scottish flows was related to pools and other map features (Avery 1989), which indicated many of our sites. However, we saw birds where 1:10,000 maps showed no bog or pool, but where we saw flushes, pools and bogs too small to print on maps. Dunlin abundance is related to ground characteristics between pools as well as to total pool area (Lavers *et al* 1996). Also, flushes over base rich rock on Glas Maol held far more birds than at the same altitude and aspect on Cairngorms granite. Both types can have continuous vegetation, but Dunlin food may abound more on base rich sites.

Nests were in low plants, unlike many Norwegian nests seen by RR in dwarf birch *Betula nana* and willow *Salix* spp up to 30cm. However, these were semi-open at the side, unlike tall heather, so physical structure be involved rather than height. Tall subalpine scrub is rare on UK peat due to overgrazing and burning, but we think that Dunlin would nest in it if it were here.

Decline in numbers

Since 1987 we have not seen birds at 8 low sites showing habitat loss or deterioration. The Braemar and Luibeg cases involved more Red Deer cropping plants and trampling pools. Although Dunlin numbers on 8 high areas in Table 2 changed little between years, the moorland ones had very few deer in summer and all 8 no deer in winter. The rise in deer density, including on grouse moors where deer were formerly rare, threatens Dunlin habitat. In the 1990s we saw 1000 deer at a time on Moine Mhor and the Mounth. They damage plants and peat, and trample bird nests (Thompson *et al* 1996). Gamekeepers W Potts and J Robertson (*pers comm*) noticed fewer Dunlin south of Loch Muick since a 1975-79 peak. Red deer increased two and a half times in 1966-86 in a block that includes Muick, faster than in Scotland generally (Youngson & Stewart 1996).

The Dunlin decline may be more complex; JR (*pers comm*) said fewer returned after the hard 1981-82 winter, and many die on English estuaries in hard winters (Clark *et al* 1993a). Probably Scottish breeders winter further south, but evidence from ringing is scanty and some may die in hard weather. Also, some estuary habitat has been lost to industry (Clark *et al* 1993b).

Conclusion

We reject recent statements indicating Dunlin scarcity in north east Scotland. Though

localised, they are fairly common and our estimates are minimal. Dunlin are one of several hill species easily overlooked when breeding. These are unsuitable for rapid surveys of all species by many observers.

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Appendix 1 Literature account

1 Harvie-Brown & Buckley 1895. Hinxman, a few on hilltop peat Glen Livet, many 1893 Upper Cabrach/Blackwater hilltops and glen mosses Cairnbrallan (all north of Ladder Hills).
2 Sim 1903. A few breed St Fergus links, Loch of Strathbeg and other suitable localities.
3 Gordon 1912, 1915, 1925. Bred Forvie and Moine Mhor (detail SG pers comm) and 1 on Monadh Mor.
4 Nethersole-Thompson 1966. Isolated pairs or communities wherever there are high peat mosses on Mounth and Cairngorms.
5 Watson 1966, Cairngorms area. Small groups SW Cairngorms and Moine Bhealaidh, and many Clunie-Glen Ey hills. Odd pair or 2 Abernethy foothills (D Nethersole-Thompson).
6 Nethersole-Thompson 1973. Big groups Moine Mhor. High numbers Angus and Aberdeenshire Mounth (in field with AW).
7 Nethersole-Thompson & Watson 1974. Wide distribution on map (p258). DNT, formerly 1-2 pairs Loch Morlich, and AW saw them 1947. From AW, 1 or 2 Loch Davan, pairs 1400-1600 ft Luibeg, Loch Builg, Bynack (Mar), and elsewhere, scores of pairs Glas Maol and Carn an Tuirc to Glen Clova and Lochnagar (RR later saw 37-60 pairs), also good on Glen Ey hills, Moine Mhor and Moine Bhealaidh. On a few hills, eg Cairn of Claise and Moine Mhor, more than Dotterel, and locally more than Golden Plover. Nests sparsely high Invermark, Glen Muick, Balmoral and Atholl, and Ladder Hills. Though near the mark on much visited land, this underestimated numbers on land that was then less visited by AW (the 'sparsely' cases).
8 Sharrock 1976. BTO survey 1968-72. Bred 3 coastal and 2 inland 10km squares, possibly another 4 inland.
9 Buckland *et al* 1990. Regional survey 1981-84, scarce breeder Loch of Strathbeg and 3 inland 10km squares, probably bred 6, possibly 5. We found breeders in all these.
10 Cook 1992. 1980s Moray survey, scarce breeder, in our area bred in 4 tetrad squares, including 7 pairs Lecht/Carn Mor (Ladder Hills). Others near Forres outside our area.
11 Gibbons *et al* 1993. BTO survey 1988-91,

in our area bred in 15 of the 10-km squares, plus seen in 2 inland and 1 coastal.
12 Bates *et al* 1993. 280 pairs Grampain Region and adjacent parts of Tayside and Highland, not based on Bates *et al* fieldwork, no detail on numbers or locations or sources, and coincided in time and in the 280 figure with local birdwatchers' hearsay from RR earlier in our study.

1 and 4-7 show many (and 4-7 wide distribution), 8-11 scarcity, and 12 should be discounted.

Appendix 2 Behaviour and breeding through the season

The first birds usually arrived at the end of April, but later in years of much winter snow. The earliest were singles on 15 and 20 April near Glas Maol. They arrived after Golden Plover and often after Dotterel. By early May they were on most sites, and in brief snowstorms were seen sheltering in pairs close together, but after deep snowfall they vanished till the main thaw.

First eggs hatched on 7-14 June (cf Nethersole-Thompson & Watson 1974), on the Ladder Hills <1 week earlier than on alpine Mounth land and about the same time in warm Mays, and the highest Cairngorms pairs nesting 1-2 weeks later. Snowfall delayed nesting (cf Nethersole-Thompson & Nethersole-Thompson 1986). In 1995 the Ladder Hills had far more new snow than at the same altitude by Loch Muick, and their Dunlin hatched a week later. In 1977 the main thaw on the high Cairngorms came on 18 June, and high pairs did not nest till the last week of June.

Strongly demonstrative display with young waned after 4 days and ended at about 7-8 days. Most hens vanished by the time young reached 10 days, and cocks took over (Cramps & Simmons 1983). Birds with big young >2 weeks could be seen by scanning from vantage points, at up to 200m. Work at this stage merely showed minimum adult numbers and whether young had been reared. As young 2-3 weeks old were usually apart (often 200-300m), and young from 2 broods can mingle, it was impossible to count separate broods and young per brood without ringing.

Many young were fully plumaged by mid July apart from downy tufts, and most by the end of July (cf Nethersole-Thompson & Watson 1974). Usually, young in their last half week were unattended by adults. In late July we saw young singly (occasionally 2 together) without adults, eg 5 single young on 3 hills on 18 July 1993, which could only just fly. However, young were occasionally attended by an adult or less often by a pair, eg a full grown young with a pair on 20 July 1969 on Ladder Hills. At Glas Maol on 29 July 1969, a chick about two-thirds grown was with an adult pair in alarm, and a pair in alarm with a chick almost fully grown.

Most Dunlin had gone by 1 August, and earlier in dry summers such as 1994 when most attempts failed. The last seen with young was on 9 August in Glen Esk. We saw singletons in flocks of Dotterel and Golden Plover until mid August, but such birds might be migrants.

Appendix 3 Main soils and plant communities in main breeding habitats

Dunlin on alpine land bred on
a) freely drained alpine sod podzols with a thin organic layer, and sparse vegetation dominated by Three-leaved Rush, grit and

boulders (community U9 in the National Vegetation Classification (NVC) of Rodwell 1991, 1992),
b) freely drained alpine podzols with a thicker organic layer, and vegetation dominated by Mat Grass (Rodwell's U8), or Stiff Sedge *Carex bigelowii* (U10), or lichen heath (H13 & 19), and
c) blanket peat with much Harestail Cotton Grass *Eriophorum vaginatum* (M19).

Glentworth & Muir (1963) defined peat soils as having >30cm of organic matter above mineral soil. Many big subalpine peatlands lay at 800-900m on the Mounth and at Moine Mhor and Moine Bhealaidh in the Cairngorms, and small alpine ones in the Mounth up to 1030m on Cairn of Claise by Glas Maol and to 1080m on White Mounth by Loch Muick. Each held breeding Dunlin. Alpine gleys due to waterlogging were frequent in a), b) and c) beside flushes.

Most Dunlin seen bred at 450-800m, reflecting the altitude of a) 'blanket hill peat', and b) 'flushed blanket hill peat' (1: 63 360 Soil Survey of Scotland). Most of a) had Cross-leaved Heath *Erica tetralix*, *Sphagnum* moss and Harestail Cotton Grass, with some Heather *Calluna vulgaris* and Deer Sedge *Scirpus cespitosus* (Rodwell's M15-17), and with less heath and more *Sphagnum* at pools (M2) and hollows. Most of b) had sedge *Sphagnum* mires (M6), or wet grassland with tall rushes *Juncus* spp (M23). Some on 'basin, valley and terrace peat' up to 550m bred in heath like a).

We saw most Dunlin on hill peat >1m thick, and highest densities on peat >2m. Plants were short, especially on wet rarely burnt land. On a flat with high Dunlin density on Monaltrie Moss, the lichen *Cetraria nivalis* at 570m indicates severe conditions; usually it is at >900m (Purvis *et al* 1992), and the lowest sites seen elsewhere on our area were at 800m on exposed ridges.

Adults used other habitats, such as flying up to 1.5km to feed at lochans where we saw none breeding. On flushed peat, a few with young were on short grass and moss with some rush tufts by slow streams and pools (eg at 400m at Abergeldie by Ballater, where RR saw at least 3 pairs in 1971 and 1972), and on wet ground without pools (eg south of Morven).

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Dunlin at nest *E Pickard*

Changes in breeding bird populations in peatlands and young forestry in north east Sutherland and Caithness between 1988 and 1995

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As part of a long term study of breeding birds in north east Sutherland and Caithness, peatland areas were surveyed in 1988, 1991 and 1995. Nineteen plots (2.5km x 2.5km) were surveyed in all 3 years. Plots were surveyed once in May and once in June. Counts of birds recorded during transect surveys were used as an index of abundance. Skylark indices showed significant declines between 1988 and 1991, and between 1991 and 1995, with an average decline of 12% per year. Indices of Red Grouse, Golden Plover, Dunlin and Meadow Pipit abundance varied significantly between years and all were lower in 1995 than in 1988. There was no correlation between changes in indices and distance to recently planted forests and no evidence of an increase in Crow numbers. These surveys suggest dramatic declines in an upland breeding Skylark population, and, together with other recent work, suggest that nationally important breeding populations of some wader species on unafforested areas of peatland in Sutherland and Caithness may have declined since the late 1980s by amounts which are comparable to earlier losses due to afforestation. Point counts were made of birds in newly planted forests in the area in 1988 and 1991 and results are presented.

Introduction

Sutherland and Caithness contain the largest expanses of peatland in Britain (Stroud *et al* 1987). The area is the stronghold for some upland bird species, holding, for example, an estimated 18% and 39% of Britain's breeding populations of Golden Plover *Pluvialis apricaria* and Dunlin *Calidris alpina* respectively (Stroud *et al* 1987), and areas of high Skylark *Alauda arvensis* abundance (Gibbons *et al* 1993). During the 1980s large areas of peatland in the area were planted with exotic conifers (Avery and Leslie, 1990), causing considerable losses of breeding waders (Stroud *et al* 1987, Bainbridge *et al* 1987).

As well as direct effects through habitat loss, the new forestry plantations may have affected breeding birds of adjacent peatlands by increasing predator populations (Thompson *et al* 1988), or by affecting the local hydrology, although one 20 year Caithness study found that hydrological impacts were limited to within 20m of the forest edge (Pyatt *et al* 1992). Stroud *et al* (1990) showed that breeding densities of some wader species in the area are lower nearer to plantations. Other studies showed that this could be explained by the nature of areas selected for afforestation, rather than any 'edge effect' caused by the plantations themselves (Avery 1989, Avery *et*

al 1989). Parr (1993) found that some moorland birds suffer higher breeding failure rates nearer to plantations, and there is recent anecdotal evidence of increases of avian and mammalian predator populations in north Sutherland and Caithness, probably resulting from the favourable habitat for such species in the new plantations and a decline in keepering intensity (C Crooke *pers comm*).

In 1988 peatland plots were surveyed to test predictions of bird numbers made using satellite imagery (Avery and Haines-Young 1990). Some of these plots were surveyed again in 1991 and 1995 and these plots formed the basis of this study.

Methods - peatland plots

Square plots of unafforested peatland in Sutherland and Caithness, 2.5km x 2.5km, were selected at random within 3 strata, defined by an index of infra-red reflectance derived from satellite imagery, such that plots with a wide range of reflectances were selected (Avery and Haines-Young 1990 and 1992). Five 2.5km straight line transects were drawn across each plot, separated by 500m, with the outermost transects 250m from the edge of the plot. Transects were orientated north south or east west, whichever was more convenient for the terrain.

In 1988, 2 surveyors surveyed 37 plots. In 1991, 2 different surveyors surveyed 31 plots, permission to survey having been denied for 6 plots. In these 2 years each surveyor visited each plot once. In 1995, a different surveyor surveyed 19 plots (Figure 1), with assistance from another surveyor for 6 visits. The 19 plots chosen for survey in 1995 were all those plots surveyed in 1988 and 1991 which were either in the catchments of the Rivers Naver and Helmsdale, or further north and east, as this was the area considered to be of greatest conservation interest (Evans 1994).

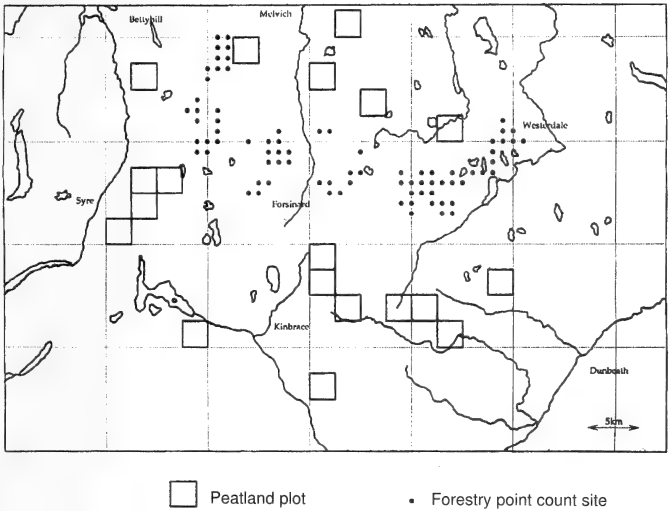
Plots were surveyed once in May and once in June by a single observer walking the transects and mapping all birds within 100m of the transect line, including common species such as Meadow Pipit *Anthus pratensis*. Surveys did not take place in continuous rain or in winds of more than 35km/hr. Surveys took place between 0900 and 1700 BST to help prevent variation in bird detectability during visits (Reed *et al* 1985, Thirgood *et al* 1995). Registrations were totalled for each visit, and the peak count (May or June) for each species for each plot was used as an index of abundance. For each plot, the distance to the nearest area of forestry, and National Grid eastings, were taken from maps to compare with changes in indices of abundance.

To determine whether counts differed between observers within years, counts of each species for each visit were compared for the 2 observers for 1988 and for 1991. Differences between observers between years could not be assessed. The visit dates for the survey years were compared for significant differences, and correlation coefficients between visit date differences and changes in indices of abundance were calculated. Counts made at the same sites on the 2 visits were compared for significant correlations, to see if counts were affected more by location than by visit date.

Methods - point counts in plantations

In 1988 and 1991, birds of new plantations in north east Sutherland and west Caithness were surveyed. Point counts were carried out at 80 sites in plantations on peatland (Figure1),

Figure 1 ***Location of peatland plots surveyed in 1988, 1991 and 1995, and forestry point count sites surveyed in 1988 and 1991.***



following the methods of Bibby *et al* (1985). Point count sites were 1km grid intersections. Sites were visited once in late April - early May and once in late May, between 0700 and 0930, and counts lasted 5 minutes. Repeat records within one point count of a bird singing from the same location were treated as records of the same bird. For each species at each point, the peak count (early or late visit) was used as an index of abundance. Planting dates were taken from forestry maps. An approximate visual estimate of the percentage cover of Heather *Calluna vulgaris* within 30m of point count sites was made in each year.

Results - peatland plots

For the 19 plots surveyed in all 3 years (Figure 1), bird abundance indices are shown in Table 1. All pair wise comparisons of years had more species showing decreasing indices than increasing indices. Differences between years were significant for Red Grouse *Lagopus lagopus*, Golden Plover, Dunlin, Skylark and Meadow Pipit. For all of these species, totals in 1995 were lower than those in 1988. For Skylark, but no other species, declines were significant for both 1988-1991 and 1991-1995 (Wilcoxon tests, $Z=-3.8$ and -3.6 respectively, $p<0.01$ in both cases), averaging 12% per year.

Table 1 ***Peatland plots - sum of peak counts for the 19 plots surveyed in all 3 years for all species recorded at more than 10 plots over the 3 years.***

	Peak number of registrations, Sum for all plots			Percentage change	Significance of differences between years
	1988	1991	1995	1988-1995	(**=p<0.01, *=p<0.05)
Red Grouse	80	130	37	-54	*
Golden Plover	313	235	209	-33	*
Dunlin	138	69	79	-43	**
Snipe	23	17	11	-52	NS
Curlew	29	36	25	-14	NS
Greenshank	23	28	23	0	NS
Common Sandpiper	12	5	10	-17	NS
Skylark	1235	565	238	-81	**
Meadow Pipit	989	577	533	-46	**
Wren	28	26	2	-93	NS
Wheatear	57	16	10	-82	NS
Crow	31	9	9	-71	NS

*Friedman 3-way ANOVA, N=19

For species showing significant differences in abundance indices between years (Red Grouse, Golden Plover, Dunlin, Skylark and Meadow Pipit), percentage change in indices of abundance from 1988-1995 was compared with distance to the nearest area of forestry, difference in dates of May and June visits, and eastings (Table 2). For Dunlin, the percentage decline between 1988 and 1995 was significantly correlated with eastings - the more easterly sites having the greatest percentage declines (Spearman correlation coefficient, $r_s = 0.53$, N=19, $p<0.05$). No other significant correlations were found.

In neither 1988 or 1991 was there any significant difference between observers in indices of abundance, except for visit 2 in 1988, when one observer recorded significantly more Meadow Pipits than the other. On visit 1, the same observer also recorded more Meadow Pipits, though not significantly more.

Golden Plover, Dunlin, Common Sandpiper *Actitis hypoleucos*, Skylark and Meadow Pipit were all recorded more often on June visits, by between 24% and 130%, while Red Grouse was recorded more often on May visits, by 45% (Wilcoxon tests, $p<0.01$ in all cases). Correlations between the 2 visits for counts of the same species at the same site were not significant in some years for some species, suggesting that within year variation between visits was often greater than variation between sites. A further test of the reliability of the survey data was carried out for the 5 species showing significant between years variation (Red Grouse, Golden Plover, Dunlin, Skylark and Meadow Pipit). Data for the 3 survey years were combined and tested to see if May counts at the 19 sites surveyed in all

Table 2 ***Peatland plots – for all plots surveyed in all 3 years the table gives the % change in abundance indices for species showing significant variation between years, eastings, forest distances and difference in survey dates.***

Plot	National grid eastings of west edge of plot (km)	Distance of edge of plot to nearest forestry (km)	Difference between visit dates (1988 date minus 1995 date) (days)		Percentage change between 1988 and 1995 in indices of abundance				
			May	June	Red Grouse	Golden Plover	Dunlin	Skylark	Meadow Pipit
3	2725	4	11	6	-80	400	0	-59	-29
4	2750	2.25	11	6	-50	200	50	-85	-22
5	2725	5.5	-12	-10	-100	200	0	-89	-34
6	2700	9	2	4	-100	-50	0	-68	-58
7	2725	2	3	5	150	-95	0	-63	-53
8	2825	0	-4	-2	-50	-50	-89	-94	-46
9	2900	4.5	14	8	0	167	-33	-95	-46
10	2925	4	11	2	0	-83	0	-91	-31
11	2950	2	-12	-21	-50	-36	-45	-91	-47
12	3025	0.75	2	-20	-100	-48	0	-89	-67
16	3075	5.75	25	26	0	-48	-63	-62	-13
18	3025	9.25	-11	-18	-100	-58	-85	-94	-78
19	3000	7	-7	-11	-67	-32	-74	-74	-49
20	2975	7.5	-7	-11	14	-68	-38	-43	-47
22	2925	4.5	1	-1	-50	-18	-15	-25	59
23	2900	0	3	-6	-56	-33	-40	-92	-77
24	2900	1.5	3	-6	-100	-23	-30	-71	-48
25	2900	11.5	21	22	-88	-60	-100	-87	-53
27	2775	10.5	-5	-4	100	-9	0	-80	-46

years were correlated with June counts. Significant ($p<0.05$) correlations were found for all species apart from Meadow Pipit (Spearman rank correlations). This suggests that for all species apart from Meadow Pipit, variation in counts between sites was greater than variation between visits, and therefore that counts for these species principally reflected the number of birds present at a particular site, rather than the visit date.

Results – point counts in plantations

Mean planting date at the 80 point count sites (Figure 1) was 1984 (range: 1980-1988). The estimated percentage of heather within 30m of point count sites increased significantly from a mean of 35% in 1988 to 60% in 1991 (Wilcoxon test, $Z=5.72$, $p<0.01$, probably because of heather colonising exposed ploughed peat, and a reduction in grazing pressure.

Point counts of Golden Plover, Skylark, Meadow Pipit were lower in 1991 than in 1988, by between 36% and 54% (Table 3). Counts of Red Grouse, Wren *Troglodytes troglodytes*, Song Thrush *Turdus philomelos*, Coal Tit *Parus ater*, Willow Warbler *Phylloscopus trochilus* and Redpoll *Carduelis flammea* increased by between 78% and 1300%. Counts of the following species were positively correlated with plantation age at point count site: Common Gull *Larus canus*, Wren, Robin *Erithacus rubecula*, Coal Tit, Willow Warbler, Chaffinch *Fringilla coelebs* and Redpoll (Table 4). Counts of the following species were negatively correlated with plantation age: Golden Plover, Snipe *Gallinago gallinago*, Greenshank *Tringa nebularia*, Skylark and Meadow Pipit.

Discussion

The declines in wader populations caused by afforestation in north east Sutherland and Caithness are well known. Recent work in the same area (Whitfield 1996) comparing surveys in 1979-87 with surveys in 1993-94 has established that recent declines in wader populations have also occurred in unafforested peatland areas. Whitfield estimates that, for Dunlin and Greenshank, similar numbers of breeding birds have been lost since new planting ceased as were lost over the same length of time when afforestation was at its peak. Whitfield also recorded Golden Plover declines. The results presented here reinforce these concerns for Golden Plover and Dunlin. If the declines recorded by this survey were representative of Sutherland and Caithness, then losses of breeding Golden Plover and Dunlin from unplanted areas in the period 1988-95 would have exceeded earlier losses due to afforestation. Applying the declines recorded from this survey to the estimated proportions of the British population of Golden Plover and Dunlin in the area from Stroud et al (1987), suggests that 7% and 17% of the British populations of these species respectively could have been lost on unafforested peatland in the area.

Elsewhere, a review of changes in populations in British breeding birds since 1800 (Gibbons *et al* 1996) suggests that Golden Plover is one of 26 species to have declined most in the last 200 years. In Ireland, the number of counties with breeding Golden Plover has declined by 63% from 1875-1 900 to 1968-72 (Holloway 1996). Gibbons *et al* (1993) show an 8% contraction in Golden Plover range between 1968-72 and 1988-91. Thom (1986) records Golden Plover declines in south west Scotland and Orkney.

Table 3 ***Point counts – variation with year of survey (sum of peak counts for all points for the 2 years of coverage, for all species recorded at more than 10 points over the 2 years).***

	Sum of peak counts		Significance of differences between years (*=p<0.05, **=p<0.01)
	1988	1991	
Greylag Goose	33	44	NS
Red Grouse	17	33	*
Golden Plover	43	20	**
Snipe	24	20	NS
Curlew	50	38	NS
Greenshank	51	27	NS
Black-headed Gull	52	38	NS
Short-eared Owl	15	9	NS
Common Gull	13	11	NS
Skylark	301	172	**
Meadow Pipit	435	280	**
Wren	19	102	**
Robin	5	8	NS
Song Thrush	1	14	**
Coal Tit	6	25	**
Willow Warbler	27	48	**
Crow	11	12	NS
Chaffinch	18	36	NS
Redpoll	21	104	**

* Wilcoxon paired sample tests, N=80.

However, Whitfield (1996) found recent increases in breeding Golden Plover populations in Lewis and Harris. Little is known about the reasons behind these changes. Recent studies in north east Sutherland (O'Connel *et al in prep*) have shown that Golden Plover feed on improved pastures up to 10km from their peatland nesting areas, but suggest that the availability of such habitat does not limit Golden Plover numbers in the study area. Elsewhere, however, such habitat may be more important, either during or outwith the breeding season. The wintering areas of Golden Plover breeding in north Scotland are unknown, however, nearby Orkney, where 2 Sutherland ringed Golden Plover have been recorded (Thom 1986), holds a large wintering population (Lack 1986).

Dunlin numbers have declined recently in upland areas of south west Scotland, probably due to afforestation (Gibbons *et al* 1993), and also in lowland areas of Scotland (Thom 1986). A recent analysis of Scottish Natural Heritage data for Sutherland and Caithness

Table 4 ***Point counts – variation with plantation age (sum of peak counts for all points for the 2 years of coverage, for all species recorded at more than 10 points over the 2 years).***

	Mean peak count (birds per 5 minute count) Plantation age at point count side:		Correlation between plantation age at point count site Mean peak count	Significant of correlation (*=p<0.05, **=p<0.01)
	5 years or less	6 to 11 years		
Greylag Goose	0.57	0.38	-0.53	NS
Red Grouse	0.28	0.30	0.22	NS
Golden Plover	0.78	0.18	-0.67	*
Snipe	0.45	0.11	-0.87	**
Curlew	0.59	0.56	-0.46	NS
Greenshank	0.70	0.30	-0.95	**
Black-headed Gull	0.35	0.81	0.28	NS
Short-eared Owl	0.21	0.05	-0.54	NS
Common Gull	0.03	0.30	0.80	**
Skylark	4.21	1.67	-1.00	**
Meadow Pipit	4.99	3.57	-0.78	*
Wren	0.07	1.55	0.97	**
Robin	0.00	0.20	0.89	**
Song Thrush	0.00	0.23	0.64	NS
Coal Tit	0.00	0.69	0.94	**
Willow Warbler	0.02	1.09	0.98	**
Crow	0.11	0.20	0.28	NS
Chaffinch	0.00	1.01	0.94	**
Redpoll	0.06	2.04	0.99	**

* Spearman correlations, N=80.

suggests an average annual decline of 7% in Dunlin numbers in Sutherland and Caithness in the period 1979-1984 (D P Whitfield, *pers comm*). The British range of Dunlin expanded between 1968-72 and 1988-91 (Gibbons *et al* 1993), although declines in areas of high density such as Sutherland and Caithness could mean that the British population has declined overall. However, peatland breeding populations have recently increased slightly in Lewis and Harris (Whitfield 1996). The fact that the greatest percentage declines in indices of Dunlin abundance occurred in the more easterly sites is hard to explain. Many of these sites held high Dunlin numbers in 1988 and were remote from the main areas of afforestation. A model of Dunlin abundance in north east Sutherland and Caithness, partly based on results from this survey, shows most of the areas of high predicted abundance to be east of Strath Halladale (Layers *et al* 1996). The analysis for this model showed that Dunlin have a preference for flatter areas with a high availability of pools, and where the ground between pool systems is dominated by short, sparse *Trichophorum cespitosum* and *Eriophorum*. Such areas are typical of the more easterly sites in this survey.

Meadow Pipit densities increase in the early stages of afforestation, starting to decline when trees are about 5 years old (Moss 1978). Point count data from this survey are consistent with this pattern (Table 4). It is possible that numbers of Meadow Pipits on moorland plots in 1988 were swelled by additional recruitment from nearby populations in the new plantations, most of which would then have been less than 5 years old. However, the evidence of some observer bias in 1988 suggests that Meadow Pipit results should be treated with caution. Similarly, of all the species showing significant between years variation, Meadow Pipit is the only one for which counts on different visits to the same site are not significantly correlated when all 3 years data are combined. This raises the possibility that the timing of visits, or the timing of breeding, could have had a significant effect on Meadow Pipit counts, possibly explaining the observed variation between years.

Skylark numbers declined by more than 50% in Common Birds Census (CBC) plots since the early 1980s (Marchant *et al* 1990). Most of these plots are in lowland England. There has been little quantitative work on Skylarks in the uplands; indeed, for many early upland surveys, Skylarks were so abundant that they were not recorded. The abundance map for Skylark in Gibbons et al (1993) suggests that north Sutherland and Caithness may have held some of the highest densities of upland breeding Skylarks in Britain. This survey suggests that breeding populations of Skylarks in some upland areas may be declining even more rapidly than those sampled by CBC plots. Little is known about the reasons for these declines in the uplands. Skylarks breeding in the peatlands of northern Scotland probably winter on farmland elsewhere in Scotland, and although little is known of the movements of Scottish birds (Thom 1986), there is little evidence of long distance migration (Dougall 1996). In Britain as a whole, the loss of winter stubbles as autumn sowing of cereals becomes more common is probably one of the main causes of decline relating to wintering habitat (Evans *et al* 1995). However, autumn sowing is uncommon in north Scotland and the Uists, where breeding Skylarks surveyed in this study may winter.

A wide range of factors may be affecting populations of peatland breeding birds, including agricultural changes, climatic

factors, changes in moorland grazing and burning practices, moorland drainage and drainage for forestry, changes in predator populations following changes in keepering patterns and land use, fence strikes, acid deposition and habitat fragmentation caused by afforestation. Such factors may be acting over a wide area in ways not easily linked to adjacent forestry and farming practices.

The fact that many species covered by this survey were recorded more frequently on June visits suggests that a repeat survey based on a single June visit might be worth considering. A similar conclusion was reached by Avery and Haines-Young (1992). However, such an approach would be highly sensitive to the timing of breeding (Thirgood *et al* 1995) so more years' data would be needed to show long term population changes.

The results of the point count surveys in plantations are generally consistent with those of similar studies elsewhere (Avery and Leslie, 1990), showing a decline in open country species, such as Golden Plover and Skylark, and an increase in woodland species such as Willow Warbler and Redpoll. The correlation between Common Gull counts and plantation age, however, was unexpected and may be a coincidental result of the small sample size (Table 3). Alternatively, it could be explained by the fact that point count sites in the more mature plantations more often fell near flight lines used by gulls moving between lochs. The non significant positive correlation between plantation age and counts of Black-headed Gull *Larus ridibundus* (Table 4) is consistent with this explanation.

Conclusions

This survey provides worrying evidence of declines in nationally important Golden Plover and Dunlin populations in areas of apparently unchanged peatland in Sutherland and Caithness. It also suggests dramatic declines in an upland breeding Skylark population. The reasons behind these declines are poorly understood and will need be addressed if these species are to remain key constituents of the bird community of this unique area.

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Numbers of wintering seaducks, divers and grebes in the Moray Firth, 1977-1995

R J EVANS

Numbers and distribution of seaducks, divers and grebes in the Moray Firth were monitored for 18 consecutive winters. Most sections within the firth held nationally important concentrations of at least one species. The Moray Firth as a whole held internationally important numbers of Red-breasted Mergansers and Slavonian Grebes and nationally important numbers of Scaup, Eiders, Common and Velvet Scoters, Long-tailed Ducks, Goldeneyes, Goosanders and Red-throated and Black-throated Divers. Peak numbers for individual species occurred in different months from September to April. Numbers of Common and Velvet Scoters and Goosanders declined during the study period and numbers of Goldeneyes, Red-breasted Mergansers and Slavonian Grebes increased. There were changes in the distribution of Eiders and Scaup within the firth. Oil pollution had no obvious effect during the study period, but remains a potential threat. These nationally important concentrations of seaducks, divers and grebes have had no adequate statutory protection to date.

Introduction

The Moray Firth has been regarded as an important site for wintering seaducks since the nineteenth century (St John 1845, Harvie-Brown and Buckley 1895, Baxter and Rintoul 1953, Thom 1986) although counts exist only from the 1960s onwards (Milne and Campbell 1973). When exploration for oil started in the Moray Firth in the late 1970s, accurate and comprehensive data were needed on the numbers and distribution of waterfowl in order to assess any impact that oil industry developments might have. Surveys of wintering seaduck, divers and grebes were undertaken by RSPB in 1977-78 and 1978-79 (Mudge and Allen 1980). Lower intensity monitoring was undertaken during the following 2 winters (RSPB unpublished data) and surveys throughout the winter resumed from 1981-82 until 1994-5 as part of the Beatrice Field environmental monitoring programme.

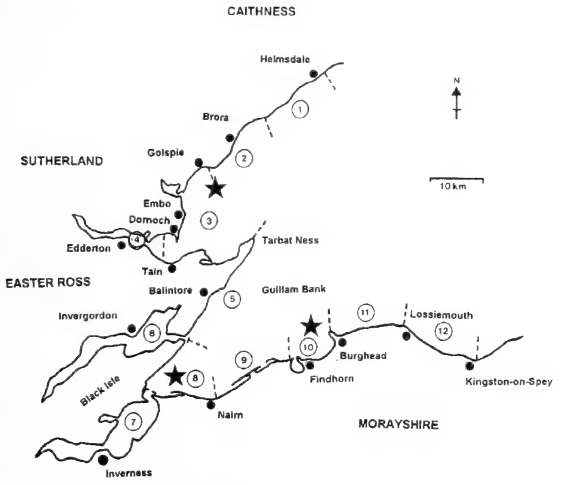
The results of this monitoring for the period 1981-82 to 1983-84 were presented by Campbell, Barrett and Barrett (1986), with supplementary papers by Barrett and Barrett (1985a) on Goldeneyes and divers (Barrett and Barrett 1985b) and by Aspinall and Dennis (1988) on Goosanders and Red-breasted Mergansers. This paper presents the results of monitoring for the whole period and discusses their implications for site safeguard purposes.

Study area

The study area extended from Helmsdale in the north to Kingston-on-Spey in the south-east and included the inner Dornoch, Cromarty and Inverness/Beauly Firths (Figure 1). The combined area is known as the Moray Firth and is described in more detail by Mudge and Allen (1980).

Daytime land based counts gave adequate population estimates for most species except Long-tailed Duck and the divers, for which supplementary land based roost counts at dawn and dusk gave improved estimates. Land based counts were supplemented by aerial and boat surveys in the earlier years of the study (Mudge and Allen 1980, Campbell et al 1986), but they were regarded as

Figure 1 ***The Moray Firth study area showing count sections: (1) Helmsdale to Brora; (2) Brora to Golspie; (3) Outer Dornoch Firth; (4) Inner Dornoch Firth; (5) East Ross Coast; (6) Cromarty Firth; (7) Inverness/Beauly Firth; (8) Riff Bank; (9) Culbin Sands; (10) Burghead Bay; (11) Burghead to Lossiemouth; (12) SpeyBay. Major Long-tailed Duck roost sites are shown by solid stars.***



Methods

The frequency of counts and the period covered by each winter's survey varied as shown in Table 1.

unnecessary in achieving adequate coverage provided daytime and dawn/dusk land based counts were made in suitable conditions. Locating the precise areas used by roosting Long-tailed Ducks could only be achieved by boat.

Table 1 ***Months in which complete surveys of the Moray Firth were carried out between 1977-78 and 1994-95.***

	Month							
Winter	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr
1977-78				*	*	*	*	
1978-79				*	*	*		
1979-80			*		*			
1980-81					*			
1981-82			*	*	*	*	*	
1982-83		*	*	*	*	*	*	
1983-84						*	*	*
1984-85	*	*		*		*		*
1985-86		*		*		*		*
1986-87		*		*		*		*
1987-88		*		*		*		
1988-89		*	*	*	*	*	*	
1989-90	*	*	*	*	*	*	*	
1990-91		*	*	*	*	*	*	
1991-92	*	*	*	*	*	*	*	*
1992-93		*	*	*	*	*	*	*
1993-94	*	*	*	*	*	*	*	
1994-95	*	*	*	*	*	*	*	

The study area was divided into 12 discrete sections (Figure 1), in which the birds could be counted by one person in a single day. Daytime land based counts were made from a number of points within each section, close enough together to ensure complete survey of the section, but far enough apart to avoid double counting.

Counts were carried out from soon after first light to approximately 2 hours before sunset, the earliest time that roost movements could be expected to disrupt daytime distribution patterns. Counts were carried out irrespective of the state of tide if weather conditions were suitable, ie no wind or light offshore winds and calm seas.

Coverage of the whole area was completed, weather permitting, in as short a period as possible and in geographical sequence in order to minimize the effect of any bird movements between sections. Although monthly differences in distribution were sometimes noticeable, short term changes on a large scale were not recorded.

Birds were identified to species whenever possible. In practice, it was not always possible to separate Common and Velvet Scoters or the diver species. Unidentified scoters and divers were therefore categorised as 'scoter sp' and 'diver sp' Campbell et al (1986) presented results for Common and Velvet Scoters combined. However, an attempt was made to estimate numbers for the 2 species separately (Kirby *et al* 1993). Unidentified scoters were assumed to occur

in the same ratio as the numbers of Common and Velvet Scoter which were positively identified and the 'scoter sp.' total was split accordingly for each site to give an estimate for each species. Unidentified divers often outnumbered identified birds so unidentified birds were not apportioned. Counts of specifically identified divers were recorded for the years 1983-84 onwards for the Moray Firth as a whole and for individual sections from 1987-88 onwards

The only seaduck species not counted reliably from the land during the day was the Long-tailed Duck. They are smaller, more cryptically coloured and tended to feed further offshore than the other seaducks, making daytime counts difficult. Therefore, counts were also made of Long-tailed Ducks flying to communal roosts at dusk, or 'occasionally' shortly after dawn. Daytime and roost counts were combined as follows: daytime counts for the 12 standard sections were made simultaneously with counts for other species. Roost counts were carried out as soon as possible before or after the daytime counts for the relevant section. Observations were made from points between known roosts in order to detect large scale movements of birds overflying one roost in preference for another. This was only recorded in 1978-79 when birds feeding over the Riff Bank were found to be roosting in Burghead Bay. Counts of birds flying to a roost site in one count section from a particular direction were presumed to have been feeding in the adjacent count section in the direction from which they had flown. The monthly count for each section was taken as either the daytime total or the roost count total, whichever was the higher. The resulting section counts were summed to give a monthly total for the whole study area

Long-tailed Duck roosts tended to draw birds from areas which were larger than the standard count sections. Five main areas for Long-tailed Duck were identified within the Moray Firth and the results are expressed in terms of these larger areas: East Sutherland (sections 1-4), East Ross (sections 5 and 6), Riff Bank/Inverness Firth (sections 7 and 8), Burghead Bay/Culbin Sands (sections 9 -11) and Spey Bay (section 12).

Eiders also used areas somewhat larger than standard count sections and three main areas were identified: East Sutherland (Sections 1-4), East Ross (Sections 5-6) and the Morayshire coast (Sections 9-12).

For each species peak counts rather than indices of site usage (cf Mudge and Allen 1980) were used to express population levels for each section and are presented in the tables. In practice, peak counts occurred in different months in different winters. Each of the 12 sections was considered in its own right so that peak counts for different sections could be made in different months in the same winter. For the whole Moray Firth monthly totals were taken and the peak monthly count for each winter was used in the tables and for analysis. Trends for each species were tested by calculating Spearman Rank Correlation Coefficients (2-tailed) between numbers and years.

The current status of seaducks, divers and grebes in the whole Moray Firth and at individual sites within the Moray Firth was expressed as the mean of peak numbers in the last 5 years 1990-91-1994-95 (Table 11). This is the standard way of assessing the importance of a site for a particular species (Pritchard *et al* 1992).

Results

Red-throated Diver *Gavia stellata*

Red-throated Diver was the commonest diver. Numbers normally peaked at around 410, out of a total diver population of around 440 (Figure 2a).

Red-throated Divers were recorded from all sections, though the largest numbers were found in sections also frequented by large numbers of seaducks, particularly the Outer Dornoch Firth, Culbin, Burghead Bay and Spey Bay. Large numbers were regularly observed flying out of the Inverness Firth during counts of roost-flighting Long-tailed Ducks (Table 2).

Numbers between 1984-85 and 1994-95 showed no trend (r_S =0.275, ns, n =11).

Peak numbers tended to occur in October, occasionally involving large gatherings, including nearly 1000 off Culbin in October 1982 (Barrett and Barrett 1985b) and 600 in Spey Bay in October 1987. Individual sections generally matched this pattern, apart from the Inverness Firth where peak numbers tended to occur between December and February. No spring passage was detected.

Black-throated Diver *Gavia arctica*

Black-throated Divers accounted for about 6% of positively identified divers. The most favoured areas were the Outer Dornoch Firth and Burghead Bay (Table 2).

Numbers between 1984-85 and 1994-95 showed no trend (r_S= 0.030, ns, n = 11) (Figure 2b).

Peak numbers occurred in October, December and during February-March. The importance of individual sites followed the overall seasonal pattern.

Great Northern Diver *Gavia immer*

Great Northern Divers were the least common of the three regularly occurring divers in the Moray Firth, accounting for roughly 4% of positively identified divers. Great Northern Divers tend to occur further offshore than other divers (Parrack 1986) and probably did so in the Moray Firth (Barrett and Barrett 1985b). Therefore it is likely that a higher proportion of the unidentified divers were in fact Great Northern Divers.

Great Northern Divers favoured the more open sections of the Moray Firth, particularly the Outer Dornoch Firth, Burghead Bay and Spey Bay (Table 2).

There was no trend in numbers between 1984-85 and 1994-95 (r_S = 0.418, ns, n=11). (Figure 2c).

There was no clear seasonal pattern either for the whole Moray Firth or for individual sites. Peak winter numbers were recorded in October, December, February and March.

Slavonian Grebe *Podiceps auritus*

Slavonian Grebes occurred regularly in the Outer Dornoch Firth between Dornoch and Embo, the Cromarty Firth , the Inverness Firth and Burghead Bay (Table 2). There were occasional records from Culbin Sands.

Numbers for the whole Moray Firth for the period 1984-85-1994-95 increased (r_S= 0.818, P<0.005, n = 11) (Figure 2d), as did numbers for Burghead Bay for the same period (r_S = 0.736, P<0.05, n = 11). It is possible that these trends were in part influenced by more

Figure 2 ***Peak total numbers of divers and grebes in the Moray Firth 1984-85 - 1994-95. a) Red-throated Diver; b) Black-throated Diver; c) Great Northern Diver; d) Slavonian Grebe.***

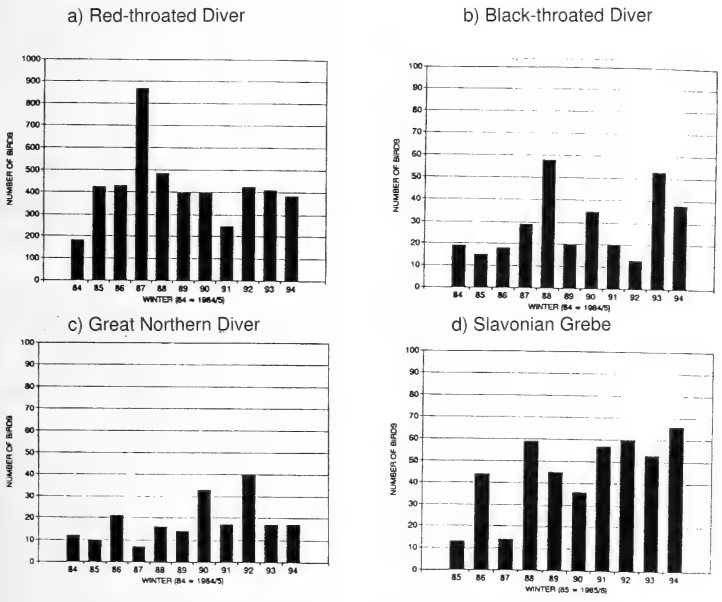


Table 2 ***Mean winter numbers of divers and Slavonian Grebes at the main sections in the Moray Firth. 1990-91 - 1994-95.***

	Outer Dornoch Firth	Cromary Firth	Inverness Firth	Culbin Sands	Burghhead Bay	Spey Bay	Whole Moray Firth
R-t Diver	80	12	154	68	74	225	459
B-t Diver	17	1	5	1	14	3	31
GN Diver	11	1	1	1	10	6	25
Slav Grebe	28	18	13	2	16	1	54

frequent surveys during the latter part of the study period (Table 1) and also by improvements in the quality of telescopes used for counting.

There was no clear seasonal pattern. Peak winter numbers were recorded in all months except September and March. This is perhaps not surprising considering that the number of birds counted depended on the weather conditions on the day of the count, in particular wind and sea state which affected the accuracy of counts of Slavonian Grebes more than other species.

Red-necked Grebe *Podiceps grisegena*

One or 2 Red-necked Grebes were recorded annually, with maxima of 6 in 1986-87 and 5 in 1991-92.

Scaup *Aythya marila*

Scaup were found almost exclusively in the Dornoch Firth, the Cromarty Firth and the Inverness Firth. Concentrations were associated with distillery and sewage outfalls at these sites. Scaup were occasionally found elsewhere, including a flock of 600 in Spey Bay in 1978-79 (Mudge and Allen 1980).

The Moray Firth wintering population peaked in most winters between 300 and 450 (Table 3) and there was no trend (Figure 3a). Numbers in the Dornoch Firth were higher (up to 650) during the early part of the study but declined latterly (r_S = -0.709, P<0.002, n=18). Peak numbers in the Cromarty Firth gradually increased (r_S= 0.920, P<0.001, n = 18). Numbers in the Inverness Firth were more variable, peaking between 50 and 200.

Numbers for the whole Moray Firth tended to peak between December and March, with most peak winter totals in February (8 out of 17 winters for which data are available). At individual sites, peaks occurred in every month from October to April with peak numbers occurring earlier in the winter (November to January) in the Cromarty Firth than in the Dornoch and Inverness Firths (December to March).

Eider *Somateria mollissima*

The most important areas were East Sutherland (Sections 1-4) and Morayshire (Sections 9-12) (Table 4). Flocks could be found off both rocky and sandy shores in these areas.

No trend was detected in peak numbers for the Moray Firth as a whole (Figure 3b). However, there was an increase on the Morayshire coast (r_S =0.732,P<0.001, n = 18) and a decrease on the East Sutherland coast (r_S = -0.589,P<0.02, n =18).

Peak numbers for the whole Moray Firth occurred during September - December and most frequently in October or November, the latter months accounting for peaks in 13 out of 18 winters. Numbers in the study area tended to drop as each winter progressed, implying that emigration to other parts of the Scottish coast occurred. Peak totals for East Sutherland occurred in October more frequently than in December but the reverse was the case for Morayshire. Peak numbers for East Ross occurred most frequently in January and February, probably reflecting dispersal of the large numbers in the north and east of the study area.

King Eider *Somateria spectabilis*

One to 3 drake King Eiders were recorded almost annually throughout the study period,

Figure 3 ***Peak total numbers of seaducks in the Moray Firth 1978-78 - 1994-95. a) Scaup; b) Eider; c) Common Scoter; d) Velvet Scoter; e) Long-tailed Duck; f) Goldeneye; g) Red-breasted Merganser; h) Goosander***

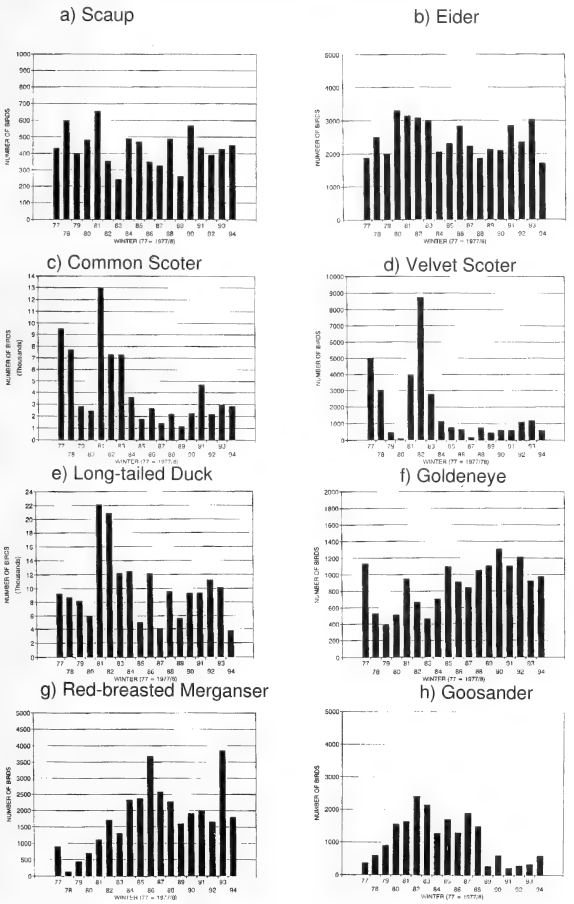


Table 3 ***Five season (* = 3 season) means of Scaup at the main sectons in the Moray Firth 1977-88 - 1994-95.***

Winter	Dornoch Firth	Cromary Firth	Inverness Firth	Whole Moray Firth
1977-78 - 1979-80	*333	*1	*49	*478
1980-81 - 1984-85	435	36	73	445
1985-86 - 1989-90	209	142	112	380
1990-91 - 1994-95	146	308	131	456

Table 4 ***Five season (* = 3 season) means of Eider at the main sections in the Moray Firth, 1977-78 - 1994-95.***

Winter	Sutherland	East Ross	Morayshire	Whole Moray Firth
1977-78 - 1979-80	*1985	*180	*573	*2125
1980-81 - 1984-85	2368	234	788	2916
1985-86 - 1989-90	1500	236	805	2273
1990-91 - 1994-95	1336	232	1258	2410

associated particularly with the Eider on the east Sutherland coast. There were also a few records from the Morayshire coast.

Common Scoter *Melanitta nigra*

Common Scoter occurred regularly in 4 sections of the Moray Firth: the Outer Dornoch Firth, Culbin Sands, Burghead Bay and Spey Bay. Smaller, occasional flocks occurred at Brora and over the Riff Bank.

During 1977-78 and 1978-79, the most important site for Common Scoter was Spey Bay, where around 6000 birds were present each winter (Mudge and Allen 1980). Numbers there declined until 1986-87 when the peak count was only 18 birds. Over the following five winters, numbers increased steadily and in 1991-92 and 1992-93 over 1000 birds were present. It was the most important site in the Moray Firth for Common Scoter in 4 out of 18 winters, including 1992-93 when peak numbers here equalled the peak numbers in Burghead Bay.

Variations in peak numbers at other sites were not as extreme as at Spey Bay. The Outer Dornoch Firth held over 1500 between 1981-82 and 1984-85, but subsequently peak numbers were about 250 in every winter except 1991-92. It was the most important site in the Moray Firth in 2 out of 18 winters. Culbin Sands had 4400 in 1981-82, but never

more than 1500 in any other winter. It was the most important site in the Moray Firth for Common Scoter in 4 out of 18 winters. Burghead Bay held peak numbers in excess of 1000 more often than any other site in the Moray Firth (12 out of 18 winters) and was the most important site in 9 winters. Numbers declined at Burghead Bay (r_s= -0.703. P<0.002, n = 18). Despite large fluctuations in numbers elsewhere, no other section showed a trend.

A decline in Common Scoter numbers for the whole Moray Firth was recorded (r_s = -0.513, P<0.05, n = 18) (Figure 3c). During 1977-78 -1978-79 and 1981-82 - 1982-83, Common Scoter numbers peaked each winter between 7500 and 13500 (Mudge and Allen 1980, Campbell et al 1986). Peak numbers failed to exceed 4000 between 1983-84 and 1990-91, and in 1989/90 reached only 1175.

During 1991-92 numbers were higher than during the mid 1980s, peaking at 4700 in April 1992.

Winter peaks occurred in every month from October to April, but most frequently in February (6 out of 18 winters). There was no clear seasonal pattern at individual sites. Each site showed a winter peak as late as April and the Outer Dornoch Firth had peak winter counts in every month from September to April, with December the most frequent (6 out of 17 winters). Numbers at Spey Bay peaked only once before December in the 17 winters for which data are available and peak counts were fairly evenly spread between the remaining months. Peak counts at Culbin occurred most frequently between December and February, while peak numbers in Burghead Bay were spread mainly between October and February.

Velvet Scoter *Melanitta fusca*

Velvet Scoter tended to occur in the sections also favoured by Common Scoter.

As with Common Scoter, the section showing the greatest variation in numbers was Spey Bay and the section with the least variation was Burghead Bay. Numbers at Spey Bay ranged from 5000 during 1977-78 to only 8 in 1986-87; numbers increased again in subsequent winters. It was the most important section in the Moray Firth for Velvet Scoters in 5 winters up to 1983-84 and none subsequently. Burghead Bay held at least 100 birds in every winter for which data were available except one. It was the most important section in 10 out of 18 winters, including every winter from 1988/-89 to 1994-95. The Outer Dornoch Firth held over 3000 in 1981-82 and 1982-83, but numbers then declined sharply and peak numbers were fewer than 100 between 1986-87 and 1990-91. It was the most important section in 2 out of 18 winters. Culbin Sands never held more than 1000 birds and was the most important section only once.

The Moray Firth total peaked at over 2500 in each of the winters 1977-88 1978-79 and 1981-82 - 1983-84, but failed to exceed 1000 in each winter from 1985/6 to 1991-92 (Table 5). The decline was not significant (r_s= -0.335, ns, n = 18) (Figure 3d).

Peak winter totals for the Moray Firth occurred in October and every month from December to April, with the highest frequency falling in April (5 out of 18 winters) followed by December and March (4 each). Peak numbers at Spey Bay were spread evenly between January and April and the only section where the majority of peak winter counts occurred in December or earlier was Burghead Bay.

Table 5 ***Five season (* = 3 season) means of Common Scoters (including apportioned unidentified scoters - see text) at the main sections in the Moray Firth, 1977-78 - 1994-95***

Winter	Outer Dornoch	Culbin Sands	Burghead Bay	Spey Bay	Whole Moray Firth
1977-78 - 1979-80	* 672	* 750	* 2791	* 4030	* 6706
1980-81 - 1984-85	2341	1566	2205	1702	6715
1985-86 - 1989-90	446	683	974	202	1838
1990-91 - 1994-95	634	749	1075	1041	2996

Surf Scoter *Melanitta perspicillata*

Surf Scoter were recorded annually and the highest number recorded in a single winter was 9 birds in 1978-79, followed by 5 in 1981-82 and 1989-90. During 1990-91 and 1991-92, 12 of 15 records of Surf Scoter were associated with Velvet Scoter and the other 3 were independent.

Long-tailed Duck *Clangula hyemalis*

Although the combination of day-time and roost counts was believed to give the best possible population estimate, the possibility remains that in some winters this method did not survey all sections adequately. In particular, the Easter Ross coast (Section 6) including the Guillam Bank in mid-firth was difficult to count. In some winters, birds using this area by day (and not counted) were regularly using the Burghead Bay roost, where they were counted. Also, it is possible, although unlikely, that some roost sites were undetected

The most important sections for Long-tailed Duck were the East Sutherland coast (Sections 1-4), the Inverness Firth/Riff Bank (Sections 7-8) and Culbin Sands/Burghead

Table 6 ***Five season (* = 3 season) means of Velvet Scoters (including apportioned unidentified scoters - see text) at the main sections in the Moray Firth, 1977-78-1994-95***

Winter	Outer Dornoch	Culbin Sands	Burghead Bay	Spey Bay	Whole Moray Firth
1977-78 - 1979-80	* 169	* 499	* 777	* 2690	* 2835
1980-81 - 1984-85	2228	225	744	1537	3357
1985-86 - 1989-90	99	193	359	37	562
1990-91 - 1994-95	223	159	519	207	815

Table 7 ***Five season (* = 3 season) means of Long-tailed Ducks at the main sections in the Moray Firth, 1977-78-1994-95***

Winter	Sutherland	Riff Bank/ Inverness Firth	Burghead /Culbin	Spey Bay	Whole Moray Firth
1977-78 - 1979-80	* 1252	* 4602	* 2719	* 1595	* 8723
1980-81 - 1984-85	3975	1225	9538	702	14741
1985-86 - 1989-90	1303	2115	4814	304	7281
1990-91 - 1994-95	998	2588	4864	1257	8744

Bay (Sections 9-11). Roosts for these areas were, respectively, between Brora and Golspie, over the Riff Bank and in Burghead Bay (Figure 1). Smaller numbers were found off the East Ross coast and in Spey Bay. Distribution between the 3 most important sections changed considerably over the study period. The Riff Bank, which held large numbers in the winters 1978-79 and 1990-91 had few in the intervening years. Large numbers were found along the East Sutherland coast in the early to mid-1980s, but many fewer during the early and later years of the study. The Burghead - Culbin area held larger numbers more frequently than the East Sutherland coast or the Riff Bank. Shifts of importance between areas occurred too frequently for any trends to be detected for individual sections.

No trend in numbers was detected for the Moray Firth (r_S = -0.119, ns, n =18) (Figure 3e) and numbers fluctuated considerably from winter to winter. Between 8000 and 12500 were found in most (11 out of 18) winters (Table 10). Much higher numbers (over 20000) were found in 1981/2 and low numbers (fewer than 6000) in 5 out of 18 winters. Between 1984-85 and 1990-91 peak numbers alternated between average (4 winters) and low (3 winters). There was no clear pattern to changes in the peak numbers of Long-tailed Ducks detected each winter. It is possible that between year differences in numbers were influenced by differences in distribution or survey intensity.

Peak winter totals occurred between November and February, with an even spread between months. Individual sections reflected this pattern, although winter peaks at individual sections were also recorded in October, March and April.

Goldeneye *Bucephala clangula*

Prior to 1977-78, large numbers of Goldeneyes were regularly present at sewage and distillery outfalls at Invergordon and Burghead, but these declined after changes were made to the quality of the effluent from these outfalls (Barrett and Barrett 1985a). The Longman outfall at Inverness was the only site in the Moray Firth where large volumes of untreated sewage were regularly discharged up to 1994-95 and this site attracted a large proportion of the Moray Firth population (Table 8).

Over the 18 years numbers of Goldeneyes increased in the Moray Firth (r_S = 0.545, $P<0.05$, n = 18), due to changes in the

Table 8 ***Five season (* = 3 season) means of Goldeneyes at the main sections in the Moray Firth, 1977-78 - 1994-95***

Winter	Cromarty Firth	Inverness Firth	Burghead Maltings	Whole Moray Firth
1977-78 - 1979-80	* 406	* 154	* 219	* 685
1980-81 - 1984-85	256	423	23	662
1985-86 - 1989-90	254	571	30	1002
1990-91 - 1994-95	184	738	38	1103

Inverness Firth (r_S = 0.750, P<0.001, n = 18). Numbers decreased in the Cromarty Firth (r_S = -0.618, P<0.01, n = 18).

Peak numbers occurred in all months between November and March, but mainly in January and February, when freshwater sites were most likely to be frozen

Red-breasted Merganser *Mergus serrator*

The Inverness/Beauly Firth and the Riff Bank were the main sections for Red-breasted Mergansers and large numbers were also found in the Outer Dornoch Firth, in the Cromarty Firth and off Culbin Sands (Table 9),

Survey techniques for Red-breasted Mergansers were believed to have improved during the 1970s (Aspinall and Dennis 1988), so the upward trends for the whole Moray Firth (r_S = 0.637, P<0.01, n = 18) (Figure 3g), Culbin (r_S = 0.601, P<0.01, n = 18) and the Riff Bank (r_S = 0.477, P<0.05, n = 18) might be an artefact of improved coverage. No section showed a trend for the period 1981-82 - 1994-95, when surveys had constant effort.

Peak numbers occurred in all months between October and March, but mainly during December - February (14 out of 18 winters). The Riff Bank, Inverness/Beauly and Cromarty Firths followed this pattern, whereas peak numbers at Culbin and in the Outer Dornoch Firth tended to occur either in October or during February-April.

Goosander *Mergus merganser*

Goosanders were found almost exclusively in the Beauly Firth and accurate count data exist from the mid 1960s onwards (Aspinall and Dennis 1988).

Before 1980-81, peak numbers were generally lower than 1000, but between 1980-81 and 1988-89 numbers peaked at more than 1200 in every winter (Table 10). Thereafter, numbers were much lower, peaking between 200 and 600.

No significant trend was detected for the study period (r_S = -0.426, ns, n=18) (Figure 3h), nor for the 31 year period for which good data exist (r_S=0.151, ns, n = 31). Peak winter counts for the period 1981-82 -1994-95 showed a strongly significant downward trend (r_S = -0.176, P<0.001, n =14).

Peak numbers generally occurred during November-January.

Table 9 ***Five season (* = 3 season) means of Red-breasted Mergansers at the main sections in the Moray Firth, 1977-78 - 1994-95***

Winter	Outer Dornoch Firth	Cromarty Firth	Inv'ness /Beauly Firth	Riff Bank	Culbin Sands	Whole Moray Firth
1977-78 - 1979-80	* 315	* 450	* -	* 123	* 246	* 496
1980-81 - 1984-85	574	341	770	559	47	1431
1985-86 - 1989-90	234	509	964	963	161	2498
1990-91 - 1994-95	192	283	1115	826	326	2242

Table 10 ***Five season (* = 3 season) means of Goosander on the Beauly Firth, 1977-78 - 1994-95***

Winter	Beauly Firth
1977-78 - 1979-80	* 620
1980-81 - 1984-85	1800
1985-86 - 1989-90	1331
1990-91 - 1994-95	415

Discussion

Although many sections within the Moray Firth qualify as nationally important in their own right, the arguments of Campbell *et al* (1986) that the Moray Firth should be treated as a single site because of changes in the relative importance of individual sites between years have been borne out by continued monitoring. Long-tailed Duck and Scaup illustrate this point. Winter numbers of both species in the Moray Firth have remained fairly stable at around 10000 and 350 respectively, but distribution within the firth has changed, gradually in the case of Scaup and more erratically in the case of Long-tailed Duck.

Despite reductions in the numbers of some wintering species, the Moray Firth remains one of the prime seaduck sites in Britain and Ireland, holding around 40% of British wintering Long-tailed Ducks and 30% of British wintering Red-breasted Mergansers (Kirby *et al* 1993). The most dramatic change has been the reduction in peak numbers of Common and Velvet Scoters. There is no apparent reason for this change; similarities in seaduck diet (eg Nilsson 1972) imply that altered food availability should cause changes in numbers of most seaduck species, not one or two.

Scoter numbers fluctuate considerably, at other Scottish sites eg St. Andrews Bay (Milne and Campbell 1973). In the nineteenth century, St. John (1845) wrote of 'considerable numbers' of scoters in the Moray Firth, while 50 years later Harvie-Brown and Buckley (1895) described the status of scoter in the firth as 'not particularly abundant'. More recently, Scottish Bird Reports show that between 1970-71 and 1976-77 peak winter numbers of Common Scoters in the Moray

Table 11 ***Sections of the Moray Firth which hold internationally (**) or nationally (*) important concentrations of individual species.***

	SECTION												
SPECIES	1	2	3	4	5	6	7	8	9	10	11	12	ALL
Red-throated Diver			*				*		*	*		*	*
Black-throated Diver			*							*			*
Slavonian Grebe			*			*	*			*			**
Scaup				*		*	*						*
Eider		*	*							*	*	*	*
Common Scoter			*						*	*		*	*
Velvet Scoter			*						*	*		*	*
Long-tailed Duck		*	*				*	*		*		*	*
Goldeneye						*	*						*
R-b Merganser			*			*		*	*				**
Goosander							*						*

Note: See text for fuller description of distribution of Eider and Long-tailed Duck.

Firth ranged from 6000 to 14000. Such high numbers were not present during the 1960s (RH Dennis, *pers comm*).

Campbell *et al* (1986) found that the Moray Firth held internationally important numbers of Long-tailed Ducks, as well as Common and Velvet Scoter. This is no longer the case for Long-tailed Ducks because of increased winter population estimates for north-west Europe, which raised the qualifying level for international importance from 5000 to 20000 (Laursen 1989).

Numbers of Goosanders on the Beauly Firth declined during the study period. The increase during the 1980s was attributed to the introduction of a fisheries ban (Aspinall and Dennis 1988) whereas the decline during the latter years of the study coincided with reductions in numbers of other fish eating birds, notably Red-breasted Merganser and Cormorant *Phalacrocorax carbo* using the Beauly Firth. Red-breasted Mergansers were apparently able to redistribute to other parts of the Moray Firth, but Goosanders did not. There has been an overall decline in the number of Goosanders recorded winterirg in the UK (Waters and Cranswick 1993). This is of particular concern at a time when there is continuing pressure from fisheries interests in Scotland to shoot more Goosanders under licence (Carss 1994).

Nationally important concentrations of Goldeneyes and Scaup were associated with sewage and distillery outfalls at 3 sites in the Moray Firth; Edderton Bay, the Cromarty Firth off Invergordon and at Inverness. Reductions in Goldeneye numbers at Invergordon and Burghead, which no longer holds nationally important numbers of

Goldeneyes, coincided with changes to the quality of effluent at these sites (Barrett and Barrett 1985a). Similar changes are currently in train at Inverness, with further changes proposed. These are likely to have a further effect on the distribution of Goldeneyes and Scaup within the Moray Firth.

The current study was initiated in order to monitor wintering seaduck populations and to determine whether oil industry developments in the Moray Firth affected them. There were no oil pollution incidents affecting large numbers of seaducks, divers and grebes in the Moray Firth during the study period and the Beatrice Field is now nearing the end of its planned production phase. However, with the difficult process of decommissioning yet to come and with the prospect of further inshore oil exploitation in the Moray Firth following the most recent licensing round, the waterfowl populations of the firth will still be at risk from oil pollution.

Commercial fisheries, including shellfisheries, can affect seaducks and other waterfowl through direct competition for food and disturbance. A commercial mussel fishery already operates in the Dornoch Firth where there was a decline in Eider numbers during the study period. There have also been attempts at commercial cockle dredging at Culbin Sands and in the outer Dornoch Firth, though to date these have largely been confined to intertidal areas little used by seaduck. The provision of artificial reefs for commercial shellfish growing has also been mooted. Clearly, there could be conflicts of interest where commercial shellfisheries and large numbers of shellfish eating birds exist side by side (Galbraith 1992).

Monitoring of waterfowl throughout the Moray Firth should be continued. In the case of seaduck, divers and grebes this requires additional coverage to that provided by the Wetland Bird Survey network.

The Moray Firth is a wetland of international importance and qualifies for Special Protection Area (SPA) and Ramsar status (Pritchard *et al* 1992). Current government guidance is that SPAs and Ramsar should be implemented through the SSSI network, which only allows for the protection of areas above the low water mark. While this is sufficient for some waterfowl, it is not for seaduck, divers and grebes, which are mainly to be found below the low water mark and thus would not be protected by SSSI designation. Provision for designation of Marine Nature Reserves under the Wildlife and Countryside Act 1981 has proved too unwieldy to deliver protection to important seaduck sites in the UK (Kirby *et al* 1993). Areas such as the Moray Firth which are important not only for seaducks but for other forms of marine life clearly require effective protection if the government is to honour its obligations under EC Directives. It is to be hoped that the opportunities for doing so under the EC Species and Habitats Directive are taken up.

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Feeding studies of the Lesser Whitethroat in Strathclyde

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The feeding behaviour of the Lesser Whitethroat was studied in Strathclyde at 2 separate territories, 43 kilometres apart. Invertebrate sampling was also carried out there and at 2 other control sites during May - July 1991 and 1992. Observations on territorial males indicated that a considerable proportion of their time was spent singing and feeding in the upper canopy level. Various feeding strategies of which pecking was the most common were identified and appear to be dependent on prey type and size. Video footage taken at the only accessible nest showed that caterpillars constituted 86% of prey items fed to fledglings. The predominant size range of caterpillars seen on video was between 6-10mm in length and that particular size range was proportionally significant in samples collected around that territory. Although our studies failed to establish a link between climate and Lesser Whitethroat distribution, climate may be an important factor in limiting Lesser Whitethroat distribution in Strathclyde through its effect on habitat.

Introduction

The Lesser Whitethroat *Sylvia curruca* is still a comparatively scarce breeding species in Scotland. In Strathclyde, the breeding population has remained relatively stable at 9-12 pairs since 1986, with no indication of further expansion into new areas. This has been attributed to the lack of suitable breeding habitat and climatic conditions (Byars *et al* 1991). We know of no other feeding studies solely on the Lesser Whitethroat in Britain. It has been suggested by Mason (1976) that range limitations may be related to diet. Because our study sites lie at the north westerly edge of the species' breeding distribution, they provide an opportunity to study Lesser Whitethroat feeding ecology at the edge of its range.

Study areas

The majority of breeding territories which have been discovered in Strathclyde (Byars *et al* 1991) were evenly divided between 2 comparable sites, 43km apart. The Renfrewshire site, which covers a 2km^2 area south east of Paisley, contained 3 territories which were located at Dykebar and Brownside Braes. The Ayrshire site covered a slightly larger area of 2.5km^2 and is located just south of Ayr. Regular breeding territories were established at the Heads of Ayr, Burton Farm and Bracken Bay. All territories were located in areas of dense Hawthorn *Crataegus monogyna* and/or Blackthorn *Prunus spinosa* scrub with a dense mosaic understorey of Bramble *Rubus* sp, Gorse *Ulex europaeus*, Dog Rose *Rosa canina* and Goat Willow *Salix caprea*.

Study sites

Insect sampling and observations of feeding behaviour commenced when territorial males arrived back on site. The criteria for locating suitable breeding habitat and assessing site fidelity have already been discussed (Byars *et al* 1991). The sampling sites for occupied territories were located in 2 Lesser Whitethroat territories, 43km apart. The 2 control sites used for invertebrate sampling were chosen on the basis of their similar habitat characteristics to the 2 breeding territories and were 23km apart. These sites were located in 3 of the 18 climatic zones found in Scotland calculated by Birse & Dry (1971) and are based on measurements of altitude, accumulated temperature and potential water deficits. Territory 1, at Heads of Ayr, was in Zone EE a warm dry lowland region; Territory 2 and Control 2 at Brownside Braes in Renfrewshire were in Zone EM, a warm moist lowland region. Control 1 at Dalry was within Zone ER, a warm rather wet lowland region.

The vegetation profiles at these sites were as follows:

Territory 1, Heads of Ayr: The territory contains large dense patches of Blackthorn scrub (2-3m+) interspersed with mature Hawthorn (3-4m+) and a patchy understorey containing Bramble, Dog Rose and Gorse (0-2m+) This site is situated on a NNE facing slope.

Territory 2, Brownside Braes: The territory is located in a disused limestone quarry which is situated on a north facing slope. The habitat consists of mature Hawthorn scrub (3-4m+) with a dense shrub layer of Bramble, Dog Rose and Gorse (0-2m+).

Control 1, West Brownside Braes: This site contains an area of open mature Hawthorn scrub (3-4m+) with extensive Gorse and Bramble understorey (0-2m+), situated on a north facing slope.

Control 2, Dalry coal bing: A disused coal shale bing cloaked in Hawthorn scrub (2-3m+) with mixed Bramble, Dog Rose and Gorse understorey (0-2m+) on a SE facing slope.

Invertebrate sampling

Insect samples were collected from each of the 4 sites using the beating tray method (Southwood 1 978). Within each territory and control site, 30 white plastic markers were randomly placed on the vegetation at 2 different height levels. Ten markers were placed in the scrub canopy at a 2 metre height level and 20 markers were placed in taller canopy at 4 metres height level. A telescopic metre stick was then used to beat a one metre square quadrat surrounding each marker 6 times in the scrub canopy. Invertebrates which fell were collected in a metre square catching tray. All items were then "pootered" into plastic vials containing 70% ethanol for analysis. Invertebrates were classified into taxonomic orders and all items were individually measured. All invertebrate sampling was carried out on warm sunny days. Samples were collected once a month during May, June and July in 1991 and 1992.

Insect samples were also obtained using the sweep net method (Southwood 1978). A 40cm diameter sweep net was quickly trawled back and forth 6 times over a one metre quadrat, which was randomly located above the scrub canopy. Four 1 metre quadrats per territory were analysed and captured invertebrates were then collected into plastic vials containing 70% ethanol for identification. This method was used to sample flying invertebrates located in mid air above the canopy in both study territories. Sweep sampling took place during 2 warm, but relatively calm days, during May 1991 and May 1992 to maximise capture of *Diptera*.

Observation of feeding birds

Detailed observations on male spatial distribution were conducted over 2 x 10 hour periods on 2 selected dates in May 1991 and 1992 in both study territories. Ten hour periods were from 0700 to 1700 BST and observations were timed immediately after the male was located at the start of each song cycle. Specific activity, vegetation type and duration of time spent at each of the 4 height levels, ie 0-1m, 1-2m, 2-3m, 3-4m were noted. Observations stopped when the male disappeared from the vicinity and could not be relocated by song after a 10 minute period. Feeding strategies utilised by the 2 territorial males were observed in May-June 1991-92 on a non quantitative basis within the study territories. Observations of feeding bouts started immediately after the male was located by song and all feeding methods were noted in detail. Adult males are more conspicuous and easy to observe early in the breeding season as they feed quite openly in the scrub canopy. After pair bonding, observing both sexes proved extremely difficult, as Lesser Whitethroats tended to search and feed more furtively within the dense scrub canopy. However, adults appear to give a soft contact *tuc* call when approaching and leaving a nest site, so that established routes can be identified and occasionally followed.

All Lesser Whitethroat territories were mapped using the minimum convex polygon method (Kenward 1987). The enclosed habitat was then systematically searched for any indication of nest building. Once found, nests were kept under daily surveillance and the contents checked periodically. Most food collections that were observed took place within 25 metres of the nest. Only one accessible nest suitable for video footage was located during the study period.

Video monitoring

A tripod mounted VHS video camera was placed approximately 1.2 m away from the nest with magnification set to x8. The video camera was switched on manually and left to record until the battery power pack became drained after 2 hours operation. The equipment was then quickly retrieved with the minimum of disturbance to the nest. The video tape was then replayed back at Paisley University, where feeding visits to the nest could be viewed in detail and freeze framed when required. The majority of prey items were easily identified and, by using adult bill length as a reference, these items could also be individually measured. Video footage was taken on 10 June 1992 at the Heads of Ayr, when the fledglings were approximately 9 days old. To our knowledge, this video technique had never been used on Lesser Whitethroats before.

Results

Invertebrate abundance and seasonal variation *

All 4 sites revealed a uniform trend in insect abundance and most taxa were represented throughout. Statistical analyses calculated from total invertebrate numbers per site showed no significant differences between territories or control sites, although there was a significant difference in mean invertebrate numbers between the 2 years. Out of the 7 taxa groups analysed, only *Diptera* and caterpillars varied significantly between territory and control sites, especially in 1991. There were notably more *Diptera* in territories than in control sites for both years, but there were significantly fewer caterpillars recorded in territories compared to that found in the control sites during 1991. 1992 showed similar

numbers of caterpillars for both territory and control sites. Those 2 groups exhibited distinct fluctuations in populations between the 2 years.

Six different invertebrate taxa groups revealed distinct seasonal patterns of abundance in both territory and control sites. *Lepidoptera* larvae, *Diptera* and *Coleoptera* all showed peaks of abundance during May, followed by a decline in numbers during June and July. *Hemiptera* and *Opiliones* displayed a reverse of this trend, with peaks of abundance occurring during July and *Psocoptera* showed a peak of abundance in June.

Results from the sweep sampling revealed small numbers of slow moving *Diptera*, notably *Bibionidae* and *Stratiomyidae*. It appears that *Bibionidae* are favoured prey items, as male Lesser Whitethroats have been observed picking up large numbers from Goat Willow *Salix caprea* flowers. Densities of 12 *Bibionidae* per m^2 were calculated from 4 random quadrat samples taken from the *Salix* canopy.

Appendices containing details of these results have been lodged in the Waterston Library, 21 Regent Terrace, Edinburgh and may be consulted on request.

Spatial distribution

During the 2x10 hour periods, a total of 418 minutes was observed at the Heads of Ayr and 378 minutes at the Brownside Braes territory. Males appeared to spend a significant proportion of time singing along with feeding; 68% (285/418) and 60% (228/378) were recorded for this particular activity at the 2 sites. The predominant canopy at both sites differed and this was reflected in the results. At the Heads of Ayr, males spent 83% of their time in Blackthorn at the 2-3 metre level (347/418), 16% in Hawthorn at the 3-4 metre level (68/418) and less than 1% in Ash at 5+ metre level (3/418). The utilisation of Ash trees within Lesser Whitethroat territories has been observed before (Hunt 1947). At Brownside Braes, males spent 66%, a substantial amount of time in Hawthorn at the 3-4 metre level (251/378). 23% was spent in Gorse at the 1-2 metre level (87/378) and only 11% in Hawthorn at the 2-3 metre level (40/378).

Foraging behaviour

Lesser Whitethroats can appear like *Phyllocsopus* warblers, especially when they forage in the scrub canopy. This distinctive feeding behaviour has been previously noted before (da Prato 1980). Males regularly patrol their territorial boundaries, singing and feeding as they move through the upper canopy. Lesser Whitethroats obtain their prey in 4 contrasting feeding methods 1.Pecking 2.Chase and snatch 3.Brief hover and 4.Flycatching.

1. Pecking was by far the most common type of feeding activity observed at both sites and accounted for 90% of all feeding observations. Pecking itself can be further split into two types:

A Single peck. This is a pecking action towards individual food items (<5mm) dispersed on vegetation.

B Rapid pecking. This occurs when multiple food items (<5mm) are obtained by rapidly pecking into a productive area of vegetation eg leaf clumps. Lesser Whitethroats appear to use their body weight in shaking leaf clumps when they hop on to adjoining branches. Hidden invertebrates attempt to scatter when disturbed and, are quickly taken by this rapid pecking action.

Food items which had been gleaned off the foliage by pecking were too small to identify visually in the field ie <5mm. Although beat sampling can reveal the diversity of invertebrates located in the canopy, we could not identify what the males were eating.

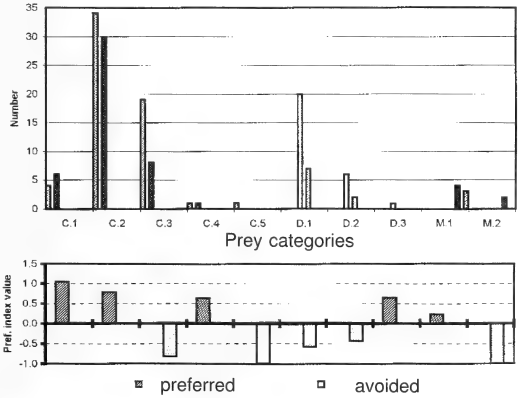
2.Chase and snatch. This strategy always involves a quick chase on moving prey, either by running along a horizontal branch in an attenuated posture, or ascending a trunk using flicked wings. Only 3 chase and snatch observations were made during the study period. The prey items caught were invariably large *Tipulids* (>10mm) which were dispatched by beating on nearby branches.

3.Brief hover. This feeding method is utilised when food items are located away from an available perch. Birds flutter very briefly for up to a second to pick at food items located on thin branch ends or in vertically placed cobwebs. This was observed 3 times during the study period

4.Flycatching. Two types of flycatching have been observed:

A Flight. Seen twice, this involves short (5-8m) one way twisting sallies from the upper canopy.

Figure 1 ***Upper plot shows numbers of prey items availabe (as recorded in beating tray samples during June 1992 at Heads of Ayr) and taken (seen to be eaten in a video recording taken during same sampling date) as left and right bars respectively for various categories C = caterpillars, D = Diptera, M = Moths; 1-5 indicate size categories 0-5mm, 6-10mm, 11-15mm, 16-20mm and 21-25mm respectively. The lower plot uses a preference index where positive values indicate relatively more prey taken than in proportion to their availability, ie preferred, and negative values indicating relative avoidance. This is calculated as (proportion taken/proportion available - 1).***



B Static. This type was observed on 6 occasions. The method comprises short neck lunges from an openly perched position on top of the canopy, often accompanied with an audible bill snap.

Only 114 minutes observation was obtained from one session in the field, during which a total of 47 food carrying visits were made: 31(66%) of such visits were made by the female; while 16 (34%) were made by the male. Fifty two invertebrate items were brought to the nest, 45 (86%) were identified as *Lepidoptera* larvae, 4 (8%) were adult *Tipulids*, and 3 (6%) were adult moths. See (Figure 1). A significant 67% of the caterpillars were in the 6-10mm size category. The female averaged 1.3 caterpillars per visit, while the male averaged 1.0. The female spent a mean of 208 seconds away (31 forays analysed), while the male spent 228 seconds away (16 forays analysed). The male was responsible for the only brooding of the young during the observation period.

Post fledging observations

Fledglings vacate the nest at around 10-11 days after hatching and hide in the dense vegetation layer (0-2m) within the territory, as their flight feathers are still in pin and not fully formed. The adults continue to feed them for a further 2 weeks, foraging in the canopy level. Food items collected by the adults could not be specifically identified during the fledgling period. Once fully fledged, juveniles roam further afield with the adults in a family party. Juveniles appear to loiter around the general vicinity of the territory for approximately 3-4 weeks before completely disappearing. Ringing studies in England have revealed that juvenile Lesser Whitethroats begin to leave their natal area once post juvenile moult has fully commenced at around 30-40 days old (Norman 1992. Boddy 1994).

Discussion

Due to their dense habitat and skulking behaviour, prolonged observations on Lesser Whitethroats are difficult during the breeding season. During early May, however, observations on established males are easier as they patrol their territories. Data collected from timed observations within sampled territories indicate that males appear to spend a considerable amount of time patrolling as they sing and feed in the canopy. This roving behaviour of the territorial males could be territorial defence, mate searching, a response to low prey density, or a combination of these factors. When adults were feeding nestlings, they seemed to largely forage within <25 metres of the nest. As invertebrates and caterpillars in particular are relatively abundant in June, the adults we studied seemed to obtain prey within a small proportion of their territory when foraging to feed their young.

Our study suggests that in Strathclyde male Lesser Whitethroat foraging behaviour depends on habitat structure. At the Heads of Ayr site, where Blackthorn covered approximately 90% of the territorial area, males consistently fed at approximately 2-3m in the Blackthorn canopy. At Brownside Braes, Hawthorn covered 60% of the occupied territory and the male Lesser Whitethroat spent more time feeding in the top (3-4m) canopy than at any other level. This suggests that invertebrate numbers were more abundant in the canopy, but our sampling data found no evidence from any of the 4 sites to confirm this theory. We need to carry out more detailed field work to investigate this. During May, males use various foraging

techniques depending on the prey item concerned. When males are hunting slow moving *Diptera* such as *Bibionidae* the prey items are easily observed and collected. However, the majority of food items taken appeared to be under 5mm in size and were not identified.

Although both sexes hunt in thick cover when foraging for their young, video evidence showed that caterpillars are important prey. If caterpillar populations fluctuate between years - as our results suggest - then fledging success may depend upon caterpillar abundance during the breeding season as caterpillars are large and relatively easy to collect. In 1992, when caterpillar numbers were higher, a brood of 5 successfully fledged at the Heads of Ayr. Clearly more nesting attempts would need to be studied to confirm this link. The timing of the nestling period coinciding with peak caterpillar abundance has been well documented and variations in such timings have been shown to affect the breeding success in insectivorous birds such as tits (Perrins, 1979, 1991) and the Pied Flycatcher *Ficedula hypoleuca* (Lundberg & Alatalo, 1992).

We previously suggested (Byars et al 1991) that the breeding population of Lesser Whitethroats in Strathclyde may be restricted by the climatic effects on prey populations. However, this study found that territories in different climatic zones did not differ in invertebrate diversity and overall numbers to any significant degree. The Brownside Braes control site had the highest total of invertebrate numbers and yet the established breeding territory was located 100 metres away outside the control area. Hawthorn scrub, which was sampled in both territories and control sites, appears to have very high invertebrate numbers and diversity and this is reflected by the variety of other insectivorous bird species which breed within all 4 sites.

Although our studies have failed to establish that climate affects Lesser Whitethroats through invertebrate distribution, it may have an important influence on habitat distribution within Strathclyde. We previously suggested that the distribution of Lesser Whitethroats in the Lothians is linked to the climatic zone defined by Birse & Dry (1971) as Zone EE, which is a warm dry lowland region below 200 metres. What appears to be ideal breeding habitat for Lesser Whitethroats can be found well over 100m in the Lothians *(pers obs)*. Climatic conditions appear to limit the growth and diversity of Hawthorn scrub over 100m in Strathclyde and this seems to restrict the extent of Hawthorn scrub within the region, whereas more favourable climatic conditions in south east Scotland allows for more widespread Hawthorn scrub and therefore a larger breeding population of Lesser Whitethroats.

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Male Lesser Whitethroat at Brownside Braes *Norman Tait*

The breeding bird community of upland Juniper scrub in eastern Scotland

S GILLINGS & R J FULLER

During spring 1997 3 sites containing Juniper scrub were censused to describe the breeding bird communities present. A combination of territory mapping and transect counts recorded 18 bird species. The community was dominated by Willow Warbler, Meadow Pipit and Chaffinch but also included locally scarce species such as Ring Ouzel, Whinchat and Black Grouse. The findings are discussed in relation to the likely effects of expansion of Juniper scrub on local avian diversity.

Introduction

It has been suggested that decreases in grazing pressure and reduction of traditional upland management techniques such as burning might promote rapid scrub and woodland regeneration in the Scottish uplands (eg Usher & Thompson 1993). On some estates and reserves in the central and eastern Highlands concerted efforts are now being made to reduce numbers of Red Deer *Cervus elaphus* so it is likely that scrub will develop in several parts of the Highlands in future decades. Where regeneration occurs on open moorland the new habitats will probably support markedly different assemblages of bird species but the exact community likely to develop is not known. The British Trust for Ornithology (BTO) has been undertaking censuses within existing upland scrub of various types in order to describe the range of bird species present and the densities at which they are found. This information will be valuable in understanding the changes that might occur in bird communities with continued scrub expansion. Such knowledge is an important component in developing conservation and management policies as required (Hester 1995).

This paper reports on work undertaken in 1997 aimed at describing the bird communities found in Juniper *Juniperus communis* scrub in the eastern Highlands of Scotland. Juniper scrub is largely restricted to the east central Highlands, particularly in the Cairngorm and Monadhliath ranges where it occurs between 350m and 650m (Rodwell 1991). It may be present as open, short scrub on moorland and also as understorey in birch *Betula* and Scots pine *Pinus sylvestris* woodland. Stands are typically even aged and of low productivity (Hester 1995) hence conservation of Juniper may be an issue itself. Scrub frequently exists as complex mosaics consisting of scrub patches differing in structure interspersed with moorland grass and Heather *Calluna vulgaris*. Another aim of this study was to assess how this patchiness and structural variation affected bird community composition.

Methods

Study sites and field methods

Juniper is relatively widespread in the Scottish uplands but large tracts suitable for a study such as this are scarce. We selected 3 sites in the eastern Highlands (Table 1) dominated by Juniper but differing in the height, ground cover and shape of bushes. The locations of these sites have been withheld at the request of the landowners. All fieldwork was undertaken in May and June 1997 on dry, clear, relatively calm mornings. Sites 1 and 2 formed discretely definable plots and were censused by territory mapping. Site 3 was extensive and more suited to census by transect counts. On a preliminary visit a hand held global positioning system (GPS) was used to define the plot boundaries of Sites 1 and 2 (accurate to nearest 10m) for drawing plot maps (scale 1:2500). Each of these plots was visited twice during which the locations of all birds were recorded on the plot map using standard territory mapping notation (Marchant *et al* 1990). Site 3 was surveyed using 4 transects (total 4.02km) set out on the first bird recording visit. These crossed extensive tracts of Juniper varying in height and ground cover and followed the hill contours in order to remain at the same altitude. The GPS was used to fix the start, changes of direction and end so that the length of each transect could be derived (to nearest 10m). Each transect was visited 3 times and the direction walked was switched to reduce bias arising from decreasing song activity after dawn. All birds encountered were placed into distance bands (0-50m and 50-100m) on basic transect maps using territory mapping notation.

Basic vegetation descriptions were made at each site. The mapping plot at Site 2 was split into3 sections (A-C, Table 1) on the basis of gross vegetation differences. On Site 3 the transects were split into sections of similar vegetation by fixing the location of major vegetation transitions using the GPS. In this way the length of transect in 4 vegetation types (I-IV, Table 1) was derived. Different grazing animal populations were present at each site and this may partly explain variation in vegetation structure. Rabbits *Oryctolagus cuniculus* and Mountain Hares *Lepus timidus* were present on all 3 sites but at varying densities (see Table 1). Roe Deer *Capreolus capreolus* were seen on Sites 1 and 3 and Red Deer were seen on Site 3. Sheep were recorded only on Site 1. The fact that we did not record one or both deer species or sheep at a particular site should not be taken as an indication of their absence.

Estimation of densities

The number of registrations of each species on each visit was extracted from visit maps for Sites 1 and 2. On Site 3 only birds recorded within the 50m bands were used for density estimation (hence a 100m section is equivalent to 1ha). In all cases if an individual was recorded in more than one section (or inside and outside a plot boundary) the proportion of registrations in each section counted towards the total. Excluding Black Grouse[1], species densities were calculated using the mean number of registrations across visits. This method provides a good approximation to densities derived by territory mapping and Distance Sampling procedures (Gillings *et al* in press). Distance Sampling was not deemed necessary because of the large distances over which individuals were detectable. For male Black Grouse, which were often detected in groups, calculations used the number of males rather than the number of registrations.

Table 1 ***Summary of site details for Juniper plots in the eastern Highlands. Sites 1 and 2 were censused by territory mapping and Site 3 by transect counts. The area covered by transect counts is based on belts of 50m each side of the transect line.***

Site	Altitude (m)	Section	Size (ha)	Vegetation description
Site 1	335-366	Whole	19.6	Grass/Heather/Juniper mosaic; Juniper varied from mat like plants <0.5m tall to bushes 1.5m tall, cover in range 5-60%. Mountain Hare particularly common here.
Site 2	396-457	Whole	42.7	Grass/Heather/Juniper mosaic. The site was subdivided into 3 areas:
		A	7.2	Moor Grass; virtually no Juniper (<5% cover).
		B	17.1	Ungrazed grass/Heather; ungrazed bushy Juniper <1m tall, 40-60% cover.
		C	18.4	Short heavily grazed turf-like grass; heavily grazed (Rabbit) Juniper <1m tall, 10-60% cover.
Site 3	518-549	Whole	40.2*	Grass/Heather/Juniper mosaic. Mountain Hare present throughout. The site was subdivided into transect strips of similar habitat:
		I	14.6	Open Moor Grass/Heather; Juniper <10% cover, <0.5m tall.
		II	9.1	Juniper cover 10% - 25%, <0.75m tall (usually 0.5m).
		III	10.0	Juniper cover 26% - 59%, <1m tall.
		IV	11.2	Juniper cover 60% - 90%, <1m tall.

[1]Scientific names of birds are given in Table 2

Results

Eighteen species of bird were recorded across the 3 sites and estimated densities are presented in Table 2. Results are presented for whole sites and for the different habitats (A-B and I-IV). Willow Warbler was the commonest species in virtually all stages of Juniper scrub, followed by Meadow Pipit and Chaffinch There was much vanation in species density between sites and the different vegetation types represented by each section. Our assessment of associations of each species with the extent of Juniper cover are given in Figure 1. Curlew, Snipe and Wheatear were mostly recorded from open moorland areas. At the other extreme, Goldcrest was only recorded where tall (c2m) Juniper bushes existed. Willow Warbler was recorded throughout but increased in density with increasing Juniper cover. Total density (all species combined) increased with increasing Juniper cover and height (Figure 2).

Figure 1. ***Graphical representation of the association of each species with the extent of Juniper cover. Bar width indicates relative habitat association: narrow bars = poor usage, wide bars = regular usage, based on density estimates and field observations.***

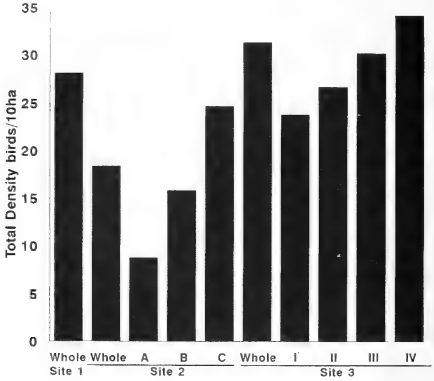
Discussion

The bird assemblage found in Juniper scrub was low in species richness and was dominated by Willow Warbler, Meadow Pipit and Chaffinch. The species recorded, and their densities, were very similar to those found in birch scrub in the eastern Highlands (Gillings *et al* in press). Both in birch and Juniper Willow Warbler densities were in the range 10-15 birds/10ha and comparable with densities in southern England and Scandinavia (Gillings *et al* in press). Meadow Pipit densities in Juniper scrub were less than half previously published densities on open moorland (Thirgood *et al* 1995). Apart from the species mentioned above, there were also notable densities of Dunnock, Song Thrush, Ring Ouzel, Whinchat and Black Grouse. Although densities of Black Grouse appear higher than those reported by Baines (1996), they are probably not representative of larger areas, and are not truly comparable because of methodological differences. Juniper scrub is not homogeneous and plots show wide variation in the extent of cover, growth form and size of bushes. Several factors may causes such variation including genetic differences, local climate (A MacDonald *pers comm*) and different grazing animals. Where abundant, Rabbits may graze the lower foliage, even within the base of the bush, producing stands that are much more open. This combined with the short, turf like

Table 2 ***Densities of breeding birds on 3 Juniper plots in the eastern Highlands. Densities are registrations per 10ha^{-1}, except Black Grouse which is males per 10ha^{-1}. Asterisks indicate species not recorded at a site.***

	Site 1	Site 2				Site 3				
Species	Whole	Whole	A	B	C	Whole	I	II	III	IV
Red Grouse *Lagopus lagopus*	*	*	*	*	*	1.0	1.0	2.2	1.0	1.8
Black Grouse *Tetrao tetrix*	0.5	1.4	0.0	0.0	3.3	1.5	0.0	3.7	0.0	0.0
Snipe *Gallinago gallinago*	1.0	0.2	0.7	0.3	0.0	*	*	*	*	*
Curlew *Numenius arquata*	*	0.8	2.8	0.3	0.5	0.1	0.0	0.3	0.0	0.0
Skylark *Alauda arvensis*	*	*	*	*	*	0.5	1.0	0.0	0.8	0.0
Meadow Pipit *Anthus pratensis*	5.1	3.6	4.2	3.8	3.3	10.6	8.6	7.9	11.8	12.5
Pied Wagtail *Motacilla alba*	*	0.1	0.0	0.0	0.3	*	*	*	*	*
Wren *Troglodytes troglodytes*	*	0.4	0.0	0.3	0.5	0.8	0.2	1.1	0.0	0.9
Dunnock *Prunella modularis*	2.0	1.9	0.0	0.9	3.5	1.0	0.2	1.5	0.2	0.4
Robin *Erithacus rabecula*	0.3	0.1	0.0	0.0	0.3	*	*	*	*	*
Whinchat *Saxicola rubetra*	*	0.1	0.0	0.3	0.0	0.2	0.9	0.0	0.0	0.4
Wheatear *Oenanthe oenanthe*	*	0.2	0.0	0.4	0.1	0.8	0.8	1.6	0.0	0.0
Ring Ouzel *Turdus torquatus*	*	0.9	0.7	0.3	1.6	0.6	0.0	0.7	0.7	0.0
Song Thrush *Turdus philomelos*	1.8	0.7	0.0	0.6	1.1	0.8	0.8	0.9	0.3	0.0
Willow Warbler *Phylloscopus trochilus*	12.5	6.4	0.4	7.8	7.5	12.4	6.5	5.7	13.7	14.7
Goldcrest *Regulus regulus*	1.0	0.1	0.0	0.0	0.3	*	*	*	*	*
Chaffinch *Fringilla coelebs*	3.3	1.4	0.0	0.9	2.5	1.2	0.2	0.0	1.7	2.2
Redpoll *Carduelis flammea*	0.5	*	*	*	*	*	*	*	*	*

Figure 2. ***The total density of all species broken down into sites, sections and habitats.***



grass sward produces a very different habitat from Juniper that is grazed only by Mountain Hares. Such spatial and structural diversity may provide many different niches for birds. Densities produced for gross vegetation types indicated that there were clear preferences by some species for different habitats on a continuum from open moorland to closed canopy Juniper thickets. Without comparable density estimates in open moorland adjacent to our study sites, it is difficult to determine how tolerant of scrub are species typically associated with open moorland. However, it is clear that Snipe, Curlew and Skylark persisted in areas where sparse, prostrate Juniper occurred. Moreover, Meadow Pipit, Ring Ouzel and Red Grouse persisted where Juniper occurred at up to 75% ground cover with some grass. A Ring Ouzel nest and several broods of Red Grouse were found within open canopy Juniper scrub on Site 3. Section C of Site 2 was Rabbit grazed grass with Juniper bushes and appeared particularly favourable for Ring Ouzels. Two pairs were recorded here, including one feeding a family of 4-5 fledglings on open lawn like turf. At the other extreme, species such as Willow Warbler, Chaffinch and Redpoll preferred more continuous tracts of tall bushes.

When predicting the effects of possible future expansion of Juniper it is clearly important to use the appropriate measure of density. This paper presents several density estimates which are applicable at different spatial scales and to different types of Juniper structure. On a small scale, Juniper scrub may be relatively homogeneous particularly as it often grows in even aged stands (Ward 1973). On a larger scale, however, the densities presented in Table 1 for specific stages will be inappropriate because scrub regeneration is likely to be

patchy and to produce mosaics of Juniper amongst Heather or grass. In these cases, the densities for whole sites might be more useful since they average out high and low density patches. Can these results be generalised to Juniper scrub in other areas of Scotland? The 3 sites used in this study exhibit a range of spatial structure, vegetation form and presence of 5 grazing animals (Rabbit, Mountain Hare, Red Deer, Roe Deer and sheep). Hence they are probably typical of Juniper scrub on moorland in the Scottish uplands but not necessarily in other habitats, for example understorey in birch woodland. The lack of study sites in the western Highlands may reduce the generality of conclusions because local bird species pools may differ, although this is unlikely to have a major effect in these simple habitats. These results suggest that colonisation of open moorland by Juniper scrub would probably cause an increase in local species richness. Scrub regeneration might be at the expense of upland breeding wader populations but there are several reasons why this might not be the case. Firstly, Juniper prefers well drained soils and will only regenerate on bare soil or recently heavily grazed swards (Miles & Kinnaird 1979) where wader populations may typically be low. Furthermore, scrub regeneration is extremely slow or non existent at the high altitudes at which waders such as Golden Plover *Pluvialis apricaria* and Dunlin *Calidris alpina* breed in eastern Scotland (Brown & Stillman 1993). On the positive side, raptor species such as Kestrel *Falco tinnunculus*. Sparrowhawk *Accipiter nisus*, Merlin *Falco columbarius* and Hen Harrier *Circus cyaneus* may benefit from an increase in the local availability of songbirds. We encountered Kestrels and Hen Harriers on or around our study areas but cannot provide any information on their use of the scrub. Also, mosaics of Juniper scrub and grass adjacent to heather moorland may be particularly beneficial to Black Grouse populations. Males from a large lek at Site 3 were often seen within the scrub during fieldwork and this habitat probably provides important daytime cover and food resources (D Baines *pers comm*).

In summary, we have found moderate to high densities of several species typical of open moorland and scrub breeding in Juniper scrub. Further expansion of Juniper scrub could be beneficial for many species, including some that are vulnerable, but possibly at the expense of strictly open moorland species More work is needed to identify the areas most likely to be colonised by Juniper and to describe the breeding bird population there so that any necessary areas of action can be identified. Future research could also focus on wide ranging species such as raptors to assess how they utilise scrub habitats.

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Willow Warbler *Sidney Clarke*

Seasonal differences in pellet remains from Golden Eagles in the Isle of Harris

A C POUT

An analysis of prey remains in pellets collected from 4 pairs of Golden Eagles in the Isle of Harris revealed that 'live prey' remains were more frequently found in pellets from the prebreeding period than from later in the season, and in pellets collected from an active nest site than from other sites within the same range during the fledging period. It is argued that these differences arise from the feeding preferences of the adult Golden Eagles. Possible reasons for such a preference and the implications are discussed.

Introduction

Golden Eagle diet in Scotland can be usefully thought of as consisting of 2 distinct components: the small and medium sized mammals and birds that Watson *et al* (1992) termed 'live prey'; and the remains of sheep and Red Deer *Cervus elaphus* that eagles scavenge as carrion. Live prey is, in the vast majority of cases, likely to have been killed by the eagles, will thus be fresh at the time of consumption, and is generally of a size that enables it to be transported by an adult Golden Eagle.

In contrast, carrion is scavenged and not killed, therefore need not be fresh when it is consumed. Due to the size of the carcasses it is not readily transportable by the eagles themselves and consequently the vast majority of the feeding occurs at the site where the animal died.

Watson *et al* (1992), in a study encompassing 9 geographic areas across Scotland, found a positive correlation between the availability of live prey and Golden Eagle breeding success, and between the availability of carrion and Golden Eagle nesting density. A suggested explanation for the relationship between live prey and breeding success (Watson & Langslow 1989) was that, as carrion was not readily transported, the feeding of the young on the nest was dependent on the availability of live prey.

In much of Scotland, and particularly the west, a substantial number of pairs of Golden Eagles is consistently recorded as being present within home ranges for which no evidence of breeding is subsequently found (Murray 1992-1996). While this may in part be due to observer effort, it also suggests that failure to lay eggs may be as important a factor as fledging success to overall breeding productivity. This study is based on pellets from Golden Eagles in South Harris, from which Red Deer are absent and where sheep are the only source of carrion, to examine seasonal changes in the live prey and carrion components of Golden Eagle diet.

Methods

Cast pellets were collected from the perches, roosts and the nest sites of 4 adjacent pairs

of Golden Eagles in the Isle of Harris, Western Isles, during 3 periods in 1996: 25 March-11 April; 26 May-2 June; and 26 August-2 September. Collections were made from the same sites during each period and, therefore, the time interval within which pellets were cast could be determined, allowing pellet contents to be related to particular periods in the breeding season of the adult Golden Eagles. The pellets collected in March-April would have been cast in the period prior to egg laying, those collected in May-June will have been cast during the incubation period and the early fledging period, and those collected in August-September will have been cast during the late fledging period and the first 4 weeks of the post fledging period. In addition, pellets cast by a young eaglet were collected from a successful nest of one of these pairs during June and August, enabling a comparison between the remains of food consumed by the young on the nest and those from food eaten by the adults of that pair away from the nest over the same time period. Prey seen on the nest was also recorded, though was not used in the analysis.

Maximum length and width of pellets was recorded and hair and feather remains were examined under x 47, x 100 and x 400 magnifications and identified with reference to Day (1966), Brunner and Corman (1974), Brom (1986) and Teerink (1991), and also by comparison with a reference collection gathered in Harris. Skeletal remains recovered from the pellets were identified from skins in the Department of Zoology, University of Aberdeen and, in one instance, from Yalden (1977).

Remains were recorded by their occurrence within a pellet, the presence or absence of live prey remains being compared. No attempt was made to relate the frequency of occurrence of remains in pellets to the frequency of occurrence of individual animals as food except when the presence of skeletal material enabled a minimum number of individuals to be inferred. Statistical tests followed Fowler & Cohen (1990).

Results

Remains of live prey were found to be present in 31 of the 51 pellets from the prebreeding period, 8 of the 23 pellets from the second collection period and 3 of the 10 pellets from the third collection period, the remaining pellets consisting entirely of carrion remains. The greater frequency of live prey remains in pellets collected during the prebreeding period in comparision with pellets from later in the season is statistically significant (X^2= 6.12, d.f.=2, $p< 0.05$). There was no evidence that the size of pellets changed over the period (Kruskal-Wallis test: K=4.12,d.f.= 2,n.s.), nor that the pellets became any more or less heterogeneous in the number of discernible prey remains a single pellet contained (X^2= 0.73, d.f.=2, n.s.).

The live prey remains recorded in pellets included 49 bird and 29 mammal items (Table 1). Of the birds, Red Grouse *Lagopus lagopus* was the most common species with 24 occurrences. Passeriform remains were found in 11 pellets; of those that were identifiable to family, 2 were corvids and one was a thrush *Turdus sp.* Three passerines were identifiable from skeletal remains as being small, ie under 40g, but were not identifiable to family. Three pellets contained the remains of diver *Gavia sp* and a Woodcock *Scolopax rusticola* was identifiable as one of the Scolopacidea recorded. A single pellet contained Grey Heron *Ardea cinerea* feathers and another contained feather remains that were unidentifiable due to lack of downy barbules.

Of the mammalian live prey, Rabbit *Oryctolagus cuniculus* was the most common single item, remains being found in 8 pellets. The remains of small mammals, such as Wood Mouse *Apodemus sylvaticus* and Pygmy Shrew *Sorex minutus*, were found in 6 pellets and a single pellet contained the fur of a cat *Felis sp.*

The 12 pellets recovered from the nest differed from 20 pellets collected from the adults of that pair over the same period in that nest pellets contained no sheep remains (X^2= 12.85, d.f.=1,p< 0.01). Red Grouse was present in 11 of the pellets and Mink *Mustela vison* fur was present in 6 pellets. A total of 27 Mink claws were recovered from these pellets indicating that at least 2 Mink must have been consumed. Prey items actually observed at the nest site included 4 Red Grouse, 1 Golden Plover *Pluvialis apricaria* chick, 1 Snipe *Gallinago gallinago*, 2 Rabbits, 2 lambs and a Wood Mouse. The surviving eaglet also consumed its sibling which died at between 2 and 3 weeks of age.

Discussion

Live prey predominated in the pellets from the young eaglet on the nest at a time when the pellets from the adult Golden Eagles of that pair contained a substantial proportion of sheep carrion. This suggests that the adult eagles are either constrained in, or discriminating between, the types of food they consume themselves and that which

Table 1 ***Frequency of indigestible remains recovered from Golden Eagle pellets, Isle of Harris in 1996.***

	25/3 to 11/4	26/5 to 2/6	26/8 to 2/9	Nest	Total
Gavia	3				3
Ardea			1		1
Lagopus	7	4	2	11	24
Charadridae	3				3
Scolopacidae	5			1	6
Passeriform	5	3		3	11
Unidentified	1				1
Sorex	1				1
Mustela				6	6
Felis		1			1
Sheep	33	18	9		60
Apodemus	3	2			5
Oryctolagus	5	2	1		8
Total occurrences	66	30	14	21	131
Total pellets	51	23	10	12	96

they use to provision their young. It also suggests that studies that do not distinguish between pellets from adults, ie those cast away from the nest site, and pellets from the young are likely to misrepresent Golden Eagle diet. The frequency of live prey remains in pellets from adult eagles during the prebreeding period also runs counter to the seasonal abundance of the live prey species present in Harris. While this may in part be explained by adult eagles feeding their young on the live prey they catch in the fledging period rather than eating it themselves, it nevertheless suggests that live prey is favoured over carrion by the adult eagles during the prebreeding period. Indeed, based on the stocking levels, reported mortality rates and the numbers of carcasses found within the ranges (own data, unpublished BSc honours project, University of Aberdeen), the availability of sheep carrion in South Harris is such that it would be feasible for Golden Eagles to feed on nothing else for the majority of the year if it were their favoured food. That so, one explanation for favouring live prey might be that there is a need for female Golden Eagles to gain body condition prior to egg production and incubation, a requirement demonstrated in Sparrowhawks *Accipiter nisus* (Newton *et al*, 1983) and argued (Ferrer, 1994) for the Spanish Imperial Eagle *Aquila adalberti*, and that the carrion that is available is nutritionally inferior to live prey in this respect. Again, were it not so then, as Brown (1969) pointed out, one would expect breeding failure to be manifest as death of the young during the fledging period due to lack of live prey delivered to the nest and not as high levels of nonbreeding. Consideration of the circumstances under which sheep die on moorland grazings suggests that many of the carcasses available to scavenging birds, at least in Harris, will be those of sheep in poor condition. Carrion is also likely to be much more variable in quality than live prey in a situation where consistency of diet over a prolonged period may be important. Barton and Houston (1993) have shown that sheep carrion has lower fat content and energy yield than Rabbit or Pheasant *Phasianus colchicus*.

Carrion abundance correlates with high Golden Eagle nesting density (Watson *et al* 1992) hence smaller relative range sizes and, everything else being equal, fewer live prey per pair. In addition, heavily grazed areas support fewer live prey than, for example, areas with good heather cover. If there is a relationship between the availability of live prey and egg production then one might expect that areas with high carrion availability and high Golden Eagle nesting density would be characterised by the widespread incidence of nonbreeding by established pairs of Golden Eagles that are able to subsist on the ample carrion that is available. This appears to be the case in South Harris where Golden Eagle density is approaching 40 pairs per 1000 km^2 of suitable habitat (Green 1996), sheep carrion is abundant for the majority of the year and, of 3 pairs of Golden Eagles monitored over an 8 year period, 2 have consistently failed to lay eggs despite regular occupancy and with no evident signs of disturbance.

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Revised manuscript accepted January 1998

Golden Eagle *Steven Brown*

SHORT NOTES

Inland Common Gull colonies in north east Scotland

Tasker *et al (Scottish Birds* 16: 106-112) reported very big gull colonies on north east Scotland moorland. Here I give past data that may throw some light on this. In 1943-48 fairly big Common Gull *Larus canus* colonies (> 100 pairs) were on Monaughty near Pluscarden, Wishach Hill (also >100 pairs of Lesser Black-backed Gulls *Larus fuscus*), Aultmore, Ordiequhish, Hill of Towie, The Balloch (>1000 pairs), and Fetteresso, and small ones south of Cuminestown on Greenness Hill (20 pairs in 1945) and Waggle Hill. At Waggle's south end in 1945, 14 pairs nested and a pair of Great Black-backed Gulls *Larus major.* At its north end, hundreds of Black-headed Gulls *Larus ridibundus* nested, many Common and Lesser Black-backed and a few Great Black-backed. The Balloch held thousands, mostly Common Gulls but many Lesser Black-backed and some Herring Gulls. Ordiequish had a few Great Black-backed pairs also.

These sites lay on heather moorland that was later destroyed by tree planting on Forestry Commission land or on private land using FC methods. Since 1970 this happened to much of the Corrennie and Suie colonies and all the Cairn Mon Earn and Spyhill ones. Birds moving from these to the increasingly few moors near the main farmland tracts may have contributed to the current big colonies.

At The Balloch, Edward Bruce (*pers comm*) said Common Gulls deserted the area within a few years of planting, but Lesser Black-backed and Herring Gulls continued to nest until tree branches met above the nests. Small areas remained unplanted at The Balloch and Hill of Towie, but gulls deserted them once the surrounding trees were >1m high. At a Mulben peat bog with stunted pines he found several Common Gulls nesting on top of the dense tree foliage. James Allan (*pers comm*) saw such a nest at Kellas moor by Elgin.

Foxes *Vulpes vulpes* were absent in the 1940s in Buchan, lower Deveron and lower Don and colonised low farmland in Banff, Aberdeen and Kincardine counties only in the 1950s (Nethersole-Thompson & Watson 1974, *The Cairngorms*). This applied also to low Moray including Pluscarden. Small gull colonies are probably more vulnerable to Foxes than big ones.

In 1945 crofters marked nests at Waggle with small cairns. They said the moor was 'moving with gulls' in the 1930s but wartime shortages led to high egg prices and the colony declined. They took each new egg about every 3 days and fresh eggs were laid into July.

Adam Watson, c/o Institute of Terrestrial Ecology, Banchory, AB31 4BY

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Hunting associations between Merlins and Hen Harriers

All the reported cases of hunting associations between Merlins *Falco columbarius* and Hen Harriers *Circus cyaneus* in winter have usually involved single birds of either species (Dickson 1993 *Scottish Birds* 17:58-59).

On 6 January 1996 at 1430 GMT on farmland in west Galloway, I watched a female or juvenile Merlin hunting 500+ Skylarks *Alauda arvensis* and 1000+ Linnets *Carduelis cannabina* without success. A ringtail Hen Harrier then hunted these same flocks but the Merlin did not take part. Thirty minutes later the harrier returned and again hunted the passerine flocks. This time the Merlin took part and, at the same time, another, smaller brown Merlin appeared. Both Merlins then attacked the passerines which were flushed by the harrier, swooping and stooping on them together in a quite spectacular manner for the next 4 minutes. The harrier landed and the Merlins began chasing each other and both flew out of sight, the larger Merlin leading. Eight minutes later the harrier resumed its hunting alone.

On only 1.4% of hunts I have watched in Galloway have 2 Merlins hunted together (Dickson 1995, *Scottish Birds* 18:165-169). The occasion where 2 Merlins hunted together in association with a hunting harrier has not been recorded before.

R C Dickson, Lismore, New Luce, Newton Stewart, Wigtownshire DG8 0AJ

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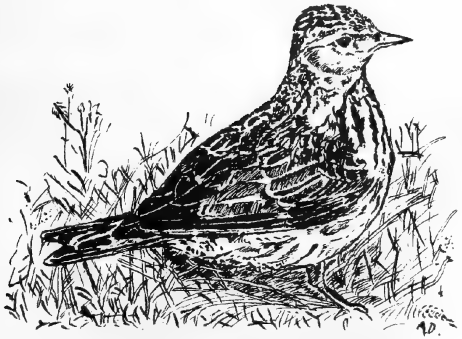

Skylark *Andy Dowell*

Double brooding by Lapwings

In 1997 a pair of Lapwings *Vanellus vanellus* nested on an island in a freshwater pool at a nature reserve in East Kilbride, South Lanarkshire. At least 3 chicks hatched on 3 May. Between 11 and 14 May one of the chicks disappeared and by 21 May only one chick remained; however, this bird fledged successfully and was seen flying on 6 June.

In late May and early June the male of the pair had been noted sitting in the same area of the original nest, but was not thought to be incubating a second clutch of eggs. However, on 13 June 4 chicks less than 24 hours old were observed. Of this second brood, only a single chick remained on 24 June, with no Lapwings at all present on 28 June - the adults either moved away with the chick, or abandoned the site following its death. *BWP* (vol 3) states the Lapwing is single brooded but replacement clutches can be laid after egg loss and that field experiments on the species have revealed that up to 4 replacement clutches can be laid following egg removal. Given a mean incubation period of 21+/- 1.77 days (n= 96) from clutch completion in a Hampshire study (mean of 28.1 days (24.7 - 34.0), n= 41, including the egg-laying period, from a Scottish study) and clutch completion in 5 days - most females lay daily (*BWP* vol. 3), then the second clutch was almost certainly started between 17 and 20 May, when there was at least one chick still present from the first breeding event. In the Lapwing, laying of replacement clutches occurs 5-12 days after the loss of a previous clutch, but it can also be triggered by loss of chicks, at least early in the season (*BWP* vol. 3).

The Lapwing nest site was approximately 30m from a frequently used public path, and the site was carefully monitored at least twice a week. No other adult Lapwings were observed anywhere in the area from 9 March to 28 July.

The East Kilbride Lapwings are of interest, therefore, in that a second breeding attempt followed a successful first one when there was no complete loss of clutch or brood, and did not involve a replacement clutch, but rather a genuine second clutch.

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Lapwing *Barry Larking*

Cormorant calls at a winter roost

Cormorants *Phalacrocorax carbo* on nesting territories are well known to show a loud and complex vocal repertoire (BWP Vol 1), yet away from this situation authorities consider that this species is usually silent. My experience is that this is certainly true of birds, singly or in groups, commuting to feeding grounds or actually fishing, but they can be very noisy at roost.

For some years I have studied a large roost in the upper Forth estuary just above Alloa, the site being 20 pairs of piers of a dismantled railway bridge. Most of these piers consist of round brick pillars, about 10m high, and the birds mainly roost (a) on the flat tops of the pillars plus top connecting struts, (b) the middle horizontal struts plus the narrow ledges formed by metal bands around the brick pillars connected to these struts. My observations refer to watches made just before sunset in autumn and winter, when up to 200 birds assemble with 15 to 20 on the more favoured central piers.

I cannnot recall a single watch which has not been enlivened by a number of loud outbursts of calling. These are usually stimulated by an incoming bird flying onto a site already occupied by 5 or more birds, but occasionally when a squabble breaks out among some that are already settled. Often a bird, either an incomer or a 'resident', is displaced in such encounters and it then flies round to make an attempt to resettle, either immediately or after resting on the water. The disturbance is thus often intensified. Two main types of call can be distinguished, though many intermediates occur. The first is a short series of low pitched, hoarse bellows or roars, describable as ' gok-gok-gok', that I would equate with the threat call described by van Tets and mentioned in BWP. The second is a more rapid series of higher pitched barks, best rendered as 'ag-ag-ag-ag-ag'; this could be similar (as a sound) to any of 4 of the intra pair calls in BWP, but I cannot see a clear relation. The roost encounters are also characterised by bill lunging and fencing (typical of territorial aggression at nest sites) (BWP) and also by the gaping display (bill up and tail up) figured in BWP and taken as a breeding season greeting ceremony that is accompanied by a loud call (not described in detail). There is no reason to suppose any greeting between the sexes when the gaping display occurs in winter roosts. In my observations the birds are some hundred of metres distant; this and the close grouping at a roost preclude a detailed study of any association between particular calls, displays and contexts. M Martin and E D Cameron have watched 2 inland roosts in trees in Perthshire, each sometimes holding 50 birds, and tell me that they have also heard loud calling in broadly similar situations during both daytime assembly (MM) and morning departure (EDC).

Loud calling is a constant feature of aggressive interactions at the Alloa roost. However, the occasional midday roosts occurring on mud banks lower down the river are quite silent even though birds are often close together. The most likely explanation is that roosting for the night involves some aspect of territoriality. There may well be some individual preferences for particular roost sites but, without marked birds, my only evidence comes from a very distinctive juvenile (with pure white underparts and a blackish cap) that was seen twice and occupied the same site on 24 January and 14 February 1997.

C J Henty, University of Stirling, Stirling FK9 4LA

Accepted March 1998

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A club has been launched to promote the study and conservation of the birds of the Neotropics (South America, Central America and the Caribbean). It is currently seeking founder members to help reach the launch budget of £2000, which is required to get the club running and to publish the two first issues of its intended journal 'Continga'. Founder members will be asked to pay a minimum of £25, and will be formally acknowledged in the first issue of 'Continga'. 'Continga' will provide a colourful and much needed forum for exchange of information on the avifauna of this extremely rich and diverse area, and will contain papers and features on the birds and their conservation as well as news of recent observations and discoveries (at present, new species are still being discovered at the rate of more than two a year). It is hoped that in due course the club will be able to provide direct funding and support for practical conservation programmes.

For further details and membership forms, please contact:
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North east Scottish counts of Goldeneye, Goosander, Red-breasted Merganser and Cormorant in 1944-50 compared with 1988-97

A WATSON, M MARQUISS & P J COSGROVE

Unpublished counts of Goldeneyes, sawbill ducks and Cormorants are presented from part of the River Deveron and other sites in north east Scotland in 1944-50 and 1997, and compared with published data from 1988-90 and 1996. The Deveron held many Goldeneyes in the 1940s, and also many other waterfowl, especially when lochs were frozen. The proportion of adult drake Goldeneyes on estuaries, at sea, and on the coastal Loch of Strathbeg exceeded that on inland waters. The numbers of Goldeneyes and Goosanders on the Deveron were higher during periods of hard frost. Adult drake Goosanders formed a minority on the Deveron and on Haddo House lakes, but a majority on Loch of Strathbeg and on Lochs Davan and Kinord. Adult drake Mergansers were in a minority on all sites. Counts from the Don estuary in 1989-90 showed no material change in Goldeneye numbers or the proportion of adult drakes since 1944-50. Counts in 1996 and 1997 show more Goldeneyes and Goosanders than on the same parts of the River Deveron in 1944-50, fewer Mergansers, and few Cormorants in both periods. Many sawbills and Cormorants were culled on the Deveron in both periods.

Introduction

Counts of wintering ducks in Britain in 1966-92 showed that most species increased over this period (Kirby *et al* 1995), but these counts were mainly at standing waters. Recent papers documenting counts in north east Scotland (Duncan & Marquiss 1993, Marquiss & Duncan 1994a, Cosgrove 1996. 1997) showed the importance of rivers for some birds such as Goldeneye *Bucephala clangula*, Goosander *Mergus merganser*, and Red-breasted Merganser *Mergus serrator*, yet few data are available for such sites. Here we document previously unpublished counts in 1944-50, to compare with 1988-97 data.

Cosgrove (1996) reported his January 1996 count of Goldeneye on all of the main stem of the River Deveron, and noted that there appeared to be no previous published data on Goldeneye there. This led AW to inspect field notes for his many counts on certain stretches of the Deveron in 1944-50, and to visit these same stretches again in January 1997. Also, Cosgrove (1997) reported his 1996 count of Goosander, Red-breasted Merganser and Cormorant *Phalacrocorax carbo* done simultaneously with his Goldeneye count. Although PC's summarised published data cannot be related to AW's data because PC used different subdivisions of the river, PC had map references for each

1996 sighting in his field notes. This enabled us to obtain his counts on the same stretches used earlier by AW. Similarly, much of MM's data in 1988-90 has been published (Duncan & Marquiss 1993, Marquiss & Duncan 1993, 1994a and b), but we returned to the unpublished field notes to compare their counts on the same stretches covered by AW in earlier years.

The aim of this paper was to find whether the numbers of these waterfowl changed between the 2 time periods, so we compared AW's 1944-50 counts
a) on certain stretches of the lower Deveron with PC's single mid January 1996 count there and 2 counts by AW in late January 1997, and
b) on other waters with MM's data in 1987-94.

Methods

Nearly all Goldeneyes in north east Scotland are winter visitors arriving in October and leaving in March, but Goosanders. Mergansers and Cormorants occur all year round (Buckland *et al* 1990). However, AW saw no Mergansers on the Deveron from April to August in 1944-50.

AW's counts from September till April were made using a telescope from concealed vantage points such as drystane dykes and shooters' hides, and binoculars where birds were confiding (eg Deveron Bridge by Turriff, Banff Bridge and Bridge of Don). Most birds remained undisturbed. This minimised errors that arise when flushed birds alight unseen on water not yet scanned. He told adult drakes from young drakes and ducks by their different plumage.

Results

Goldeneyes in 1944-50

Seasonal variation

Early dates for AW were 3 at Meikle Loch of Slains on 28 September and 3 at Loch of Strathbeg on 5 October, but an occasional bird summered on loch and river, including one with a Scaup *Aythya marila* on Deveron above Banff in 1947. Birds on the Deveron by Turriff usually came in late October, increasing till late December irrespective of frost, eg in 1946 the first seen on a 1-km stretch were 2 on 25 October, rising to 5 on 28 October, and 9 on 5 November and 18 December. In 1947, however, none came until 10 November. He saw none there after 27 March, and a last flock of 12 on the Ythan estuary on 14 April 1947. Duncan & Marquiss (1993) found similar arrival and departure times for Goldeneye on 3 other rivers and on standing waters in north east Scotland.

Counts during icy periods

Numbers on the Deveron rose after ice sealed lochs and fell after thaws. On the Turriff stretch, numbers at 1.0-4.7/km rose to 18.4/km during frost in January 1945 and 19.4/km in January-March 1947 (biggest flocks 15 and 28 respectively). After thaws in February 1945 and late March 1947, numbers fell to 4/km. Many in a flock showed sexual display on 1 February 1947, a sunny frosty day.

Flock size

The biggest flocks were of 25 on the Ythan estuary, 28 at Turriff, 33 at Boyndie Bay, 43 at Don mouth, 60 in Aberdeen Bay, and once 400 at Loch of Strathbeg when flocks up to 50 combined temporarily after disturbance by

shooting, but AW saw a flock of 100 on a day at Strathbeg with no shooters.

Proportion of adult drakes

The mean percentage of adult drakes on the Deveron at Turriff was 28%. It fell from February to March 1946 (36% to 27% in 28 and 15 seen), and from January to February 1945 (50% to 25% in 16 and 12 seen) and 1948 (63% to 54% in 16 and 13 seen), but rose from January through February to March 1947 (21% through 24% to 45% in 24. 89, and 76 seen). Variation between years was too big and sample size too lacking in independence within and between months for statistical tests to be valid.

Table 1 ***Percentage of adult drake Goldeneyes seen in 1944-50.***

		N(day n)*	%
River	Deveron, Turriff	405 (44)	28
	Deveron, Eden-Ashogle	108 (18)	21
	Deveron, Alvah	35 (3)	40
	Don, Kinaldie	10 (10)	20
	Don, Br. of Dyce	34 (32)	29
Loch	Loy	7 (7)	0
	Alvie	4 (4)	50
	of Strathbeg	c770 (c400)	60"
	Meikle Loch of Slains	96 (39)	36
	Cotehill Loch	16 (8)	63
	Haddo, Upper & Kelly	18 (18)	17
	of Fyvie	12 (3)	0
	Davan & Kinord	38 (31)	26
	of Skene	18 (18)	0
Estuary	Spey	17 (8)	35
	Deveron	121 (25)	58
	Ugie	12 (12)	25
	Ythan	94 (38)	37
	Don	213 (43)	82
	Montrose Basin	13 (12)	23
Sea	Findhorn	8 (4)	50
	Spey Bay	10 (4)	40
	Whitehills	38 (4)	82
	Boyndie Bay	66 (33)	100
	Foveran Links	72 (40)	46
	Aberdeen Bay	123 (30)	75

* N is total seen, and (day n) is biggest number seen in a day at one place.
" From a sample flock of 50.

Some seasonal variation may be confounded with frost hard enough to seal lochs and flood ponds. The percentage of adult drakes in January 1945 during frost (50% of 52 seen) exceeded that on ice free days before the frost (44% of 9 sightings) and after (21% of 14 seen). The percentages in hard frost in February-March 1947(24% of 89 seen and 31% of 103) exceeded those before the frost (22% of 27 seen), and after it in late March (25% of 8). Similarly, in frost during January 1948 the percentage exceeded that in ice free February but AW's data from December 1947 were too few for a pre January check. However, the 1946 data came from months without hard frost.

The percentage of adult drakes was high on estuaries (Table 1), especially on the Don. On one occasion AW saw birds fly from Donmouth on to the sea off the sandbar nearby, so they used both estuary and sea. The percentage of adult drakes was very high at sea, up to 100% on Boyndie Bay, Banff. On lochs near the sea it exceeded the percentage on inland lochs, especially at Loch of Strathbeg which is hard by the sea. On inland lochs it broadly resembled that on rivers, but varied considerably between one inland loch and another.

It would be invalid to apply statistical analysis and probabilities to the totals in Table 1, as they probably involved some birds seen more than once, especially at Turriff where AW did many counts on the same stretch even within a month, sometimes almost daily. However, it was valid to test numbers at different places on the same day (he often saw birds at the first site as he returned from the second), and at widely different places visited within two days (Table 2). This showed that the main differences in the percentage of adult drakes noted above at different places were very unlikely to be random.

Table 2 ***Percentage of adult drake Goldeneyes at pairs of places on the same date or similar dates***

Date	Place	%	n*	Fisher exact P
17 Feb 46	Haddo House lakes	17	18	
	Foveran Links, sea	57	30	0.014
2 Mar 46	Don, Dyce/Kinaldie	28	65	
	Aberdeen Bay, sea	75	60	<0.0001
1 Dec 46	Boyndie Bay, Banff, sea	100	33	
	Deveron, Turriff	25	12	<0.0001
14-15 Dec 46	Don mouth	69	26	
	Don, Kinaldie	20	10	0.011
19 Jan 47	Deveron estuary	60	25	
	Whitehills, sea	100	12	0.015
25 Jan 48	Loch of Strathbeg	60	50	
	Meikle Loch of Slains	32	25	0.029

* number counted

Goosanders in 1944-50

The earliest were on the Deveron by Turriff on 7 October and Meikle Loch of Slains on 14 October, and the last small groups on 20 March by Turriff. AW saw an occasional pair as late as 26 April, so perhaps they bred there. In winter, he often saw Goosanders on Deveron at Turriff and on other parts of Deveron that he visited frequently between Laithers and Banff Bridge.

Counts during icy periods

As with Goldeneyes, numbers on the Deveron by Turriff were much higher when ice sealed lochs and ponds. During such periods, the total number seen was 98, with 4.4/km, whereas during mild ice free periods the total was 61, with only 1.6/km. As successive counts cannot be regarded as statistically independent, formal analysis with probabilities would be invalid. However, out of 45 counts in mild periods, 69% had no birds, 18% one bird, 7% 2, and 7% 3 or more (up to 15) birds. In contrast, out of 22 counts in periods of frost, only 14% had no birds, 18% one bird, 27% 2, and 41% 3 or more (up to 30) birds.

On the Deveron by Turriff they sometimes flew in long strings far higher than usual (> 50 m up). This was normal on days with shooting, but at times occurred on days without shooting, when ice had sealed lochs and flood ponds. For instance, AW saw 30 in strings flying up and down the Deveron on 23 January 1947, by which time lochs had 5 cm of ice. On 12 January 1947 he saw 52 on a 3 km stretch (12 on the water and at least 40 flying up and down), when lochs and ponds in lowland north east Scotland were open but hard frost affected England and south Scotland. He noted this behaviour occasionally on days that were mild for the whole UK, eg 15 on 29 February 1948. Shooting elsewhere on the Deveron can be ruled out as an explanation, as this was a Sunday and no shooting was done on Sundays in 1944-50.

Proportion of adult drakes

Adult drakes comprised a majority at Loch of Strathbeg (64% out of a total of 42, with 15/20 in a count selected at random), and at Lochs Davan and Kinord (67% out of a total of 24, with 6/7 in a count selected at random). They were in a slight minority in most places. They comprised 42.5% out of a total of 254 seen on the lower Deveron from Laithers down to Alvah gorge (with 4/12 in a count selected at random from the Deveron stretch by Turriff), 18% in a total of 39 at Haddo House lakes (with 4/30 selected at random), and 30% out of a total of 37 at other places. A Fisher exact test showed that the difference in the proportion of adult drakes between the randomly selected Davan/Kinord count and the Haddo one was highly significant ($P = 0.0001$), and for the randomly selected counts at Strathbeg and Deveron by Turriff was significant ($P = 0.03$).

On the Deveron at Turriff, adult drakes comprised 45% of a total of 98 seen during frosty periods in 1945, 1946 and 1947 when ice sealed lochs and ponds. This included 45% out of 87 during the hard 1947 frost, when the largest flock of 30 birds contained 12 adult drakes. The proportion of adult drakes there did not differ materially during mild periods, with 44% out of 61.

The biggest flocks seen were of 30 on the Deveron at Turriff, 30 on the Upper Lake at Haddo House, and 20 at Loch of Strathbeg. AW twice saw a few fly downstream to rest on the lowest parts of the Ythan estuary including

the north bar and once a bird at sea just off Donmouth, but otherwise he saw none at sea. Some were in close pairs away from others nearby, in all winter months but especially in late winter. On 25 January 1947, 8 drakes and 4 ducks in a flock showed much chase and courtship at Alvah in hard frost.

Red-breasted Mergansers in 1944-50

AW often saw these at sea, on estuaries, on lochs near the coast, and occasionally on the lower Deveron (up to 7 at a time on the estuary) and Haddo lakes (up to 5). The sighting furthest up Deveron was a duck below the bridge by Turriff. Flocks were seen at sea (up to 26 at Boyndie Bay), and largest numbers in September-October at sea and on the Ythan estuary. Many were in close pairs, as early as 6 November on Spey. The last seen were 2 pairs on 4 May at Loch of Strathbeg and 4 pairs on 7 May at Ythan estuary, maybe on passage.

Adult drakes comprised a slight minority in December-May (46% out of 213). We regard the lower September-November value (13% out of 106) as false, due to moulting adult drakes being unrecognised then, especially when far out at sea.

Dawn and dusk flights on the Deveron at Turriff in 1944-50

All duck species present flew upstream over Deveron Bridge at dusk, mostly after sunset, and particularly so on short midwinter days with poor light, as Marquiss & Duncan (1994a) noted for Goosanders arriving at their roosting site. The Bridge was a good watch point, as they flew close above it, within a few metres if one hid low. Goldeneyes, Goosanders and many others then turned south east in the direction of Hatton Castle lochs and flood ponds on Turriff Haughs, where AW saw ducks fly in to roost on other dusks. However, a Goosander once came upstream on the dusk flight, landed on a quiet stretch above the Bridge, and stayed there until after dark. Ducks returned down the Deveron at dawn.

Cormorants in 1944-50

During each winter in 1944-50, AW saw single birds on Deveron by Turriff (once 2 together), and up to 5 at a time at Alvah gorge. He often saw them flying but also fishing on the river, and basking on rocks and trees at the gorge. They were mainly adults, but some immature. On 18 January 1947 one swam on the Deveron above the A920 bridge at 150 m altitude, above Huntly.

Shooting in 1944-50

In the 1940s, ducks other than sawbills were often shot for sport on the Deveron, occasionally including Goldeneyes (a shooter bagged 6 one evening at Forglen). Goosanders have long been shot. Every second Saturday during winter in 1944-50, many lairds and keepers had an onslaught in the afternoon, directed by the Deveron Fishery Board and aimed at killing sawbill ducks and Cormorants. Any that were missed at one spot might be shot further up or down and got no respite. The birds tended to fly directly above the river, and departed from the river line only across big bends, where shooters were placed. An immature drake Goosander injured by shooting could not fly on 29 February 1948, and PC saw an injured duck Goosander in 1996, so shooters did not adequately dispatch wounded birds.

Comparison of 1944-50 data with 1987-94

Duncan & Marquiss (1993) found that a high percentage of Goldeneyes on estuaries and at sea were adult drakes. AW's data confirm this; clearly this feature is long standing. Figure 7 in Duncan & Marquiss (1993) shows a big variation in the percentage of adult drakes on different lochs, and AW's data confirm this also.

Marquiss & Duncan (1993) noted a September-October peak of Red-breasted Mergansers on the North Esk estuary but not on the river. AW's data show a September-October peak also on the Ythan estuary and at sea.

We compared AW's data on the Don estuary with MM's data in 1988-90 to check for change in numbers or proportions of adult drake Goldeneyes. The sole count in 1988 revealed an unusually high value of 118, but it was noted as atypical because it included many birds from off the nearby sea. The only counts in 1989 and 1990, one in each January, showed 17 and 20 Goldeneyes respectively, of which 14 and 13 were adult drakes (mean 73%). This signified no material change in numbers since 1944-50, when AW's 7 counts ranged from 7 to 43 with a mean of 16. It indicated also no material change in the percentage of adult drakes which in AW's counts had a mean of 82%. The proportion in a count selected randomly from AW's data (18 adult drakes out of 24) did not differ significantly from that in a count selected randomly from MM's data (13 out of 20, chi^2=0.33).

On Lochs Davan and Kinord near Dinnet, AW's 3 counts in 1946, 1947 and 1948 showed 31, 7, and 0 Goldeneyes, little different from 5 counts run by MM in 1988, 1990, 1991, 1992, and 1994 with 33, 0,0,0 and 0. Adult drakes comprised 26% in AW's counts and 36% in MM's, and given the small sample sizes it is unsurprising that there was no significant difference (chi ^{2}=0.26).

A preponderance of adult drake Goosanders was apparent in AW's 3 counts at Lochs Davan and Kinord in 1946-48 (67% in a total of 18 birds). The larger number of counts in MM's data at these 2 lochs confirms this preponderance, with 76% adult drakes in a total of 68 birds seen during single midwinter counts in each of 6 winters in 1987-94. The 2 sets of data suggest a possible increase (mean 1946-48 count 6, range 0-11, and 1987-94 mean 11.3, range 4-22), but there were insufficient counts for analysis. Marquiss & Duncan (1994b) found a preponderance of adult drakes on the lower parts of Dee also, unlike AW's slight minority of adult drakes on the lower Deveron in 1944-50

Comparison of 1944-50 data with 1996 and 1997

As AW's data from 1944-50 showed a bigger proportion of adult drake Goldeneyes on estuaries than inland, we checked this for the Deveron using PC's 1996 field notes. These showed 61% adult drakes out of 28 birds on the tidal Deveron, but only 34% in the 273 further up (Fisher exact P = 0.006), so confirming the point. The 6l% was closely similar to AW's 1944-50 mean of 58% there (Table 1) and AW's 1997 value of 54%. PC's proportion of adult drakes in January 1996 on the Turriff stretch covered by AW in 1944-50 was 29% out of 17, broadly similar to AW's 1944-50 mean of 28%, and similar also to AW's January 1997 value of 28% there. Hence the differences in proportion of adult drakes between sites were consistent and long standing.

Comparison was made with PC's unpublished notes from the same stretches as AW covered (Table 4). This showed more Goldeneyes and Goosanders in 1996 than in 1944-50, fewer (no) Mergansers, and very few Cormorants. One must treat such comparisons with caution, as birds on a stretch of a few km may not be restricted to it. This seems likely from the high variability in AW's counts of Goldeneyes, Goosanders and Cormorants within months on the Turriff stretch (Table 3). Nevertheless, the higher values in 1996 on all 7 stretches covered in the 1940s are suggestive of an increase since 1950.

The question arises whether this was a sustained increase or merely a short term peak, as a single recent winter count cannot distinguish between these alternatives To help elucidate this, AW did a count on 2 mild, ice free days in late January 1997. On 40 km covered in both years, Goldeneye numbers were very close to PC's in 1996, with Goosanders slightly fewer; AW was told there was some Goosander shooting in the week before his counts. On one of the 2 days chosen randomly, the proportion of adult drake Goldeneyes was higher at the estuary than inland (15/28 vs 20/92, Fisher exact P = 0.002) On every stretch that AW covered in 1944-50, Goldeneye numbers in 1997 exceeded those in 1944-50, in most cases exceeded AW's highest count for the same stretches from the earlier years, and were closely similar to PC's 1996 counts for the same stretches. Hence recent high Goldeneye counts on Deveron are probably due to a real increase. This fits the overall increase in Britain generally (Kirby *et al* 1995).

Adult drakes comprised 47% of Goosanders seen on the entire Deveron in the 1996 count (Cosgrove 1997). This included a lower proportion on the section 10 km from the sea (Cosgrove's Figure 2), thus fitting in broad terms the minority of adult drakes on the low sections near Turriff in AW's 1944-50 data. AW's 2 counts in 1997 again showed a

Table 3 ***Day to day variation in counts on 2km of the Deveron by Turriff in 1944-48.***

Period	Goldeneye	Goosander	Cormorant
Jan 44	0,0,2,6	0,0,1,1	0,0,0,0
Nov-Dec 44	0,2,0,0,0,0,0	0,1,2,0,2,0,0	0,0,0,0,0,0,0
Jan 45 mild	0,0,1,5	0,0,0,2	0,0,0,0
Jan 45 frost	16,23,13	0,2,0	0,0,0
Feb 45	5,5,2,1,2,3,1	2,0,0,0,0,0,0,	0,0,0,0,0,0,0
Jan 46	7,0,0,0,0,0,0,1	2,1,1,0,1,0,1,0	0,1,0,0,0,0,0,0
Feb 46	4,3,0,2,4,2,12	0,2,0,0,0,3,0	0,0,0,0,0,0,0
Mar 46	9,0,6,4	0,0,0,1	0,0,0,0
Oct-Nov 46	2,5,3,9,0,0,0	0,0,4,0,0,0,1	0,0,0,0,0,0,0
Jan 47	7,3,2,3	12,0,0,2	0,0,2,0
Jan-Mar 47	15,29,29,19,22,	30,15,2,12,4,	0,0,0,1,1,0,
frost	15,11,37,9,15,8	1,6,2,3,2,18	0,0,0,0,0
Jan 48 frost	0,6,2,4,6	1,1,10,8,0	0,0,0,0,0
Feb 48	8,0,1,4,0,1	1,1,1,0,1,0	0,0,0,0,0,0

Table 4 ***January counts on ice free days on the Deveron in the 1940s, 1996 and 1997.***

Place	Km	Goldeneye			Goosander			Merganser	Cormorant	
		40s	96	97	40	96	97	40s	40s	96
Estuary	1.0	3.3	28	28.5	0	1	4	1.6	0	0
Alvah gorge	0.6	0.8	2	1.5	0.8	2	1.5	1.2	1.8	0
Bridge of Alvah	0.7	0.3	2	2	0.5	1	1	0	0	0
Eden-Ashogle	5.1	12.4	54	54	5.7	13	8.5	0	0	1
Turriff #	1.7	2.9	14	12.5	1.4	3	2	0.2	1.0	0
Carnoustie	0.9	0.7	3	3.5	0.4	2	1	0	0	0
Laithers	1	0.5	3	3	0.5	2	1	0	0	0
Total	11	20.9	103	105	9.3	24	19	3.0	2.8	1

1940s data are from counts on mild January days in 1944-48 (only one count in a given day at one place, number of counts ranged from 9 at the estuary to 26 at Turriff, and the mean number of counts at all 7 places was 12). The mean number of each bird species was calculated for each place in each year, and then an overall mean for that place for the five years, which is the value shown in the Table. 1996 and 1997 data cover several places in the same day. 1996 data from one count, 1997 data from 2 counts on 2 days, no Mergansers seen 1996 and 1997, and no Cormorants in 1997.

 # From 1km below Deveron Bridge to 0.7km above.

For Goldeneye and Goosander separately, the probability of obtaining all 7 of the 1996 values greater than their 1940s paired mean values is 0.016 (sign test, on the hypothesis that one would expect as many increases as decreases in each 1996 value compared with its respective 1940s paired mean). The difference in the opposite direction for Merganser is not significant, as so few sites had any.

minority of adult drakes on the lower Deveron centred on Turriff between Laithers and Alvah gorge, where a count selected randomly showed 44% out of 18, and at the estuary (25% out of 4). PC's detailed field notes show 53% adult drakes out of 32 on these 2 stretches in 1996 but only 46% out of 39 when the stretch between the estuary and Alvah gorge was included.

Cosgrove (1997) saw no Red-breasted Mergansers on Deveron, but in 1944-50 AW noted up to 7 at a time on the estuary, up to 4 at a time on deep pools at Alvah gorge, and once a duck by Turriff. In 1997 he saw no Merganser and no Cormorant on the same stretches as he covered in 1944-50.

Discussion

This paper's main conclusions are that the River Deveron's importance for wintering Goldeneyes and Goosanders is long standing, that Goldeneyes and Goosanders were more abundant in 1996 and 1997 than in 1944-50, and that the proportion of adult

drakes in both species has not changed materially. The proportions of adult drake Goldeneyes at sea, at estuaries, and at the Loch of Strathbeg hard by the coast, exceed those on inland rivers and on most lochs.

A possible explanation for the increase of Goldeneyes on the Deveron is eutrophication following more use of inorganic fertilizers on farmland, leading to more food for this duck. Another possibility is that coastal Goldeneyes declined after reduction of coastal sewage and industrial outfalls, as on coastal sites in the Moray Firth (Barrett & Barrett 1985), and may have moved to inland sites such as the Deveron. These and other possible explanations are speculative.

John Edelsten's many counts of Goldeneyes at sea between Banff Bridge and Whitehills in 1981-96 are of interest, as he found the main concentrations of them at the sewage outfalls at Banff harbour and from Ladysbridge Hospital. Numbers seen varied greatly within and between winters, the highest counts being 138 in January 1987, 222 in November 1993, and 121 in February 1994.

On the Deveron in the 1940s, much shooting of sawbill ducks and Cormorants took place in winter, in addition to other shooting. Shooting of sawbill ducks is now under licence, and numbers reported to have been shot are known (Cosgrove 1997). We do not have a record of numbers shot in the 1940s. Despite all the killing, however, Goosanders were more numerous in 1996 and 1997 than in 1944-50, though Mergansers were scarcer, and Cormorants possibly so.

Acknowledgements

We thank J Edelsten for letting us use his unpublished counts of ducks, and K Duncan for help with counts in 1989-90.

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Amendments to the Scottish List

R W FORRESTER
for Scottish Birds Records Committee

(incorporating an update to records of species recorded in Scotland on 5 or fewer occasions)

The Scottish Birds Records Committee is responsible for maintaining the Scottish List first published in 1994 (Scottish Birds 17: 146-159). This is the second subsequent report of the Committee (the first being in Scottish Birds 18: 129-131), and contains 4 additions to and one deletion from the list.

Also in 1996 (Scottish Birds 18: 132-143) SBRC detailed all acceptable records of species which had occurred in Scotland on 5 or fewer occasions. We also now update these records.

Red-breasted Goose *Branta ruficollis*
Adult Insh Marshes, Highland, 9-19 March 1994 (*British Birds* 89:485).
Adult Vane Farm, then Tayside, now Perth & Kinross, 28 September 1994 (*British Birds* 90:461).
4th and 5th Scottish records.

Lesser Scaup *Aythya affinis*
Male, St John's Loch and Loch Watten, Caithness, 1 February-10 March 1996 (*British Birds* 90:464).
4th Scottish record.

Pallid Harrier *Circus macrourus*
2nd summer male Dunkadale area, Orkney, 18 April-27 June 1995, also 13 September (*British Birds* 89:496).
4th Scottish record.

Black-winged Pratincole *Glareola nordmanni*
Juvenile, Monikie, Angus & Dundee, 14-16 August, 1996. (*British Birds* 90:468).
3rd Scottish record.

Caspian Plover *Charadrius asiaticus*
Female Skelberry, Shetland, 3-4 June, 1996 (*British Birds* 90:469).
2nd Scottish record.

Terek Sandpiper *Xenus cinereus*
Boddam, Shetland, 11-13 June 1995 (*British Birds* 89:503)
River Leven, Clyde, 22-30 September 1996 (*British Birds* 90:479)
5th and 6th Scottish records.

Forster's Tern *Sterna forsteri*
1st W Musselburgh area, Lothian intermittently from 16 December 1994 (*British Birds* 88:522) on coast from Portobello, Edinburgh to Aberlady Bay, but mainly Musselburgh, to 10 April 1995 (*British Birds* 89:507) and probably the same bird Ythan Estuary, Grampian 3 May-1 August, 1995 (*British Birds* 89:507).
2nd Scottish record.

Bridled Tern *Sterna anaethetus*
Tiree, Strathclyde, 30 June-9 July 1994 (*British Birds* 89:507).
4th Scottish record.

Eagle Owl *Bubo bubo*
Remove from Category B
Following an extensive review the BOU concluded that there was no evidence that Eagle Owl had occurred in a wild state in Britain and Ireland for over 200 years and removed the species from Category B of the British List (*Ibis* 139:198). The species had been on the Scottish List as a result of 4 records during the period 1830-1883. No Scottish records are therefore now considered acceptable and the species is removed from Category B.

Pallid Swift *Apus pallidus*
Add to Category A
Moribund, North Ronaldsay, Orkney 26 October 1996 (*British Birds* 90:490).
1st Scottish record.
There are now 5 species on the Scottish list. Only recorded as dead or dying.

Blyth's Pipit *Anthus godlewskii*
Add to Category A
1st W Fair Isle, Shetland, 31 October-4 November 1993 (*British Birds* 89:512).
1st Scottish record and 4th British record.

Isabelline Wheatear *Oenanthe isabellina*
The details for the 2nd Scottish Record were shown as "20-21 September 1993, Whalsay, Shetland" (*Scottish Birds* 18:139). The year should read 1994.

Hermit Thrush *Catharus guttatus*
1st W Fair Isle, Shetland, 19 October 1995 (*British Birds* 89:516).
2nd Scottish record.

Swainson's Thrush *Catharus ustulatus*
South Uist, Outer Hebrides, 6 October 1996 (*British Birds* 90:497).
4th Scottish record.

Veery *Catharus fuscescens*
Add to Category A
Newton, North Uist, Outer Hebrides, 20-22 October, 1995 (*British Birds* 90:497).
1st Scottish record.

Cetti's Warbler *Cettia cetti*
The details for the first Scottish record were shown as "5th October 1993, freshly dead, Leith, Edinburgh". (*Scottish Birds* 18:140). This should be changed to 4 October 1993.

Olivaceous Warbler *Hippolais pallida*
Fair Isle, Shetland, 5-13 June 1995 (trapped 5th June), (*British Birds* 89:517).
2nd Scottish record.

Southern Grey Shrike *Lanius meridionalis*
Add to Category A
The BOU have now split Southern Grey Shrike from Great Grey Shrike *Lanius excubitor* (*Ibis* 139:199). The first acceptable record was of the subspecies *L.m. pallidirostris* (also known as Steppe Shrike), trapped Fair Isle, Shetland, 22 September 1964 (*British Birds* 66:401-402).
This is both the first Scottish and 1st British record.

Tennessee Warbler *Vermivora peregrina*
Hirta, St Kilda, Western Isles, 20 September 1995 (*British Birds* 89:524).
4th Scottish record (all 4 British records are from Scottish islands).

Yellow-rumped Warbler *Dendroica coronata*
1st W North Ronaldsay, Orkney, 13 October, 1995 (*British Birds* 89:525).

3rd Scottish record.

With the addition of Pallid Swift, Blyth's Pipit, Veery and Southern Grey Shrike to Category A and removal of Eagle Owl from Category B, the totals for the various categories of the Scottish List now stand at:

Category A	458
Category B	14
Category C	6
	478
Category D	12
	490

The British Ornithologists' Union has recently separated Hume's Warbler *Phylloscopus humei* from Yellow-browed Warbler *Phylloscopus inornatus*. Several records of birds resembling *humei* are currently being examined by the British Birds Rarities Committee and we await with interest to see whether they find that any Scottish records are acceptable. It now seems only a matter of time before the BOU separates Yellow-legged Gull from Herring Gull *Larus argentatus* to enable yet another species to be added to the Scottish List. Also, we await acceptance by the British Birds Rarities Committee of the Blue-cheeked Bee-eater recorded in Shetland.

A similar system of categories has been used for the Scottish List to that used for many years by the BOU for the British List. Early in 1998 the BOU announced the introduction of a revised categories to their British List. Although they have been working on the new system for some time, they have only now published the details. Consideration will be given to the merits of revising the categories used for the Scottish List, to keep it in line with the BOU's British List.

The Scottish Birds Records Committee, which is responsible for maintaining the Scottish List now consists of Peter Gordon, Eric Meek, Kevin Osborn, David Clugston, Bruce Forrester, Ian Andrews, Colin Crooke and Ron Forrester (Secretary).

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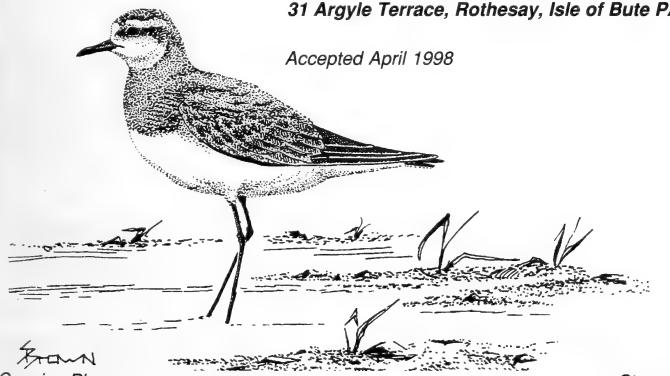


Caspian Plover *Steven Brown*

Winter habitats of Twites in Scotland

H CLARK & R M SELLERS

This paper presents the results of a questionnaire survey of habitats used by Twites in Scotland in the winter months. A variety of habitats was identified, chief among them weedy turnip fields, rape and rape stubbles, other stubbles especially barley, pasture and other farmland, waste ground, saltmarsh and beaches and the strand line. These are important both in terms of the number of areas in which they are used and the numbers of birds using them. Other habitats including pasture and other farmland, dunes and machair were also used. These results contrast with the position in England where saltmarsh is the principal habitat used. Conservation aspects of the results are discussed and attention is drawn to the declines in the acreage of turnips planted in some areas in recent years and the apparent switch to rape and rape stubbles, a new crop in Scotland.

Introduction

Scotland is one of the main strongholds in Western Europe of the Twite *Carduelis flavirostris*. Its breeding range extends in a broad but patchy band from south west Scotland through Argyll, the Western Isles and north west Scotland to Caithness and the Northern Isles with smaller numbers in the Grampians (Jardine & Reid 1993). There is a complex redistribution of birds following breeding (Clark & Sellers 1998) with the main wintering areas including south west Scotland, Argyll, south-west Perthshire, the southern part of the Outer Hebrides, certain islands of the Inner Hebrides, Orkney, Caithness and low lying areas adjoining the Moray Firth, with lesser numbers in the Borders, Lothian, Central and elsewhere (Lack 1986). The habitats used in Scotland in the non-breeding season are not well known, but, in contrast to the position in England, it is clear from the general winter distribution that both inland and coastal habitats are used. In an earlier study of Twites wintering in Caithness we found that the principal habitats used were weedy turnip fields, fields of rape and rape stubbles and noted that these agricultural habitats might be used more generally in Scotland (Clark & Sellers 1997a).

Materials and methods

The material for this study was obtained primarily from a questionnaire circulated to all local bird recorders in Scotland except Caithness which we completed on the basis of our own studies and interested birdwatchers. This solicited information on the following:

(i) Habitats used in the period November to February inclusive: Recorders were asked to assign one of the following status categories:

0 Habitats not used in winter or none of this habitat in the area

1 Occurs irregularly in winter in small numbers (flocks <30 birds)
2 Occurs irregularly in winter in moderate numbers (flocks <100 birds)
3 Occurs regularly in winter in small numbers (flocks generally <30 birds)
4 Occurs regularly in winter in moderate numbers (flocks generally <100 birds)
5 Occurs regularly in winter in good numbers (flocks of >100 birds not uncommon)

to each of the following habitat types: turnip field, rape and rape stubbles, other stubbles, pasture, other farmland, waste ground, birch woodland, machair, dunes, beaches and the strand line, saltmarsh and other. Compilers were asked to use only one abundance category per habitat, and in cases of doubt to use the highest appropriate category. For the other stubbles, other farmland and other categories, recorders were asked to provide additional information as appropriate. This list of habitat types was drawn up primarily on the basis of experience in Caithness and elsewhere in Scotland and various published sources, but was not exhaustive and the notes accompanying the survey form asked for details of other habitats where these were used.

(ii) Foods: Recorders were asked to supply any information they could on foods and, if possible, to differentiate between principal food sources and minor ones.

(iii) Area: Area to which the habitats and foods related (usually a Region or District).

Further details about the survey are given in Clark & Sellers (1997b), which includes sample copies of the survey forms.

We supplemented the information from the questionnaire with data from fieldwork carried out by ourselves, covering especially low lying land adjoining the Moray Firth, and published sources including local avifaunas and local bird reports from all parts of Scotland. We obtained sufficient information to determine habitats for all parts of the Twite's winter range in Scotland except Wester Ross and W Inverness. However, neither of these appear to be important areas for Twites in the non breeding season (*cf* Jardine & Reid 1993).

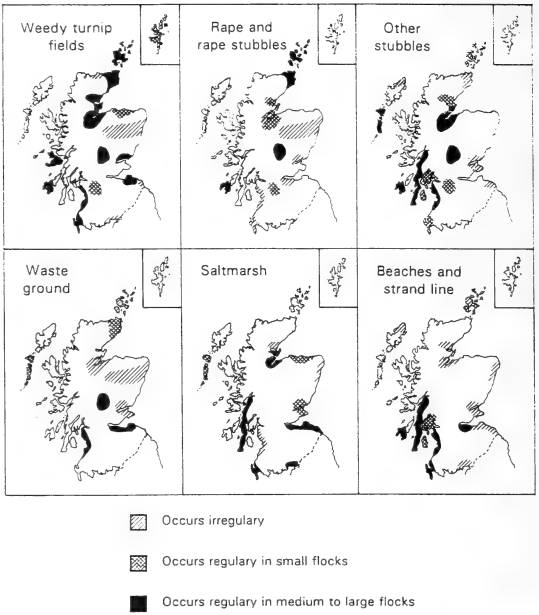
For the purposes of this study winter is taken to be the period November to February inclusive.

Results

Habitats

Table 1 shows the habitats identified in this study. They comprise 2 main types: agricultural habitats and the maritime habitats. The former category included weedy turnip fields, rape and rape stubbles, other stubbles (mainly barley), fields of potatoes, kale and other cultivated land, pasture (usually weedy pasture), crofting land, cattle feed troughs and silage rings, and set aside. The maritime habitats category covered saltmarsh, beaches and the strand line, weedy areas backing onto beaches, dunes and maritime grassland which might also be included under agricultural habitats. A number of other habitats were also recorded as being used, most importantly weedy areas such as waste ground and roadside verges (typically adjoining pasture or other agricultural land) and to a lesser extent others such as moorland and moorland edge, rough grassland and birch woodland. The latter seems surprising for a species usually

Figure 1: ***Distribution of major Twite winter habitats in Scotland***



associated with open country, but parallels some observations of Smart (1978) of birds wintering in woodland in England.

The information presented here is not quantitative and the areas in which habitats were recorded were not of uniform size. However a rough indication of the relative importance of the habitats can be judged from the number of areas from which they were recorded. The results of this are shown in the lower part of Table 1. The most widely used habitat was weedy turnip fields, followed by other stubbles, beaches and the strand line, saltmarsh, rape and rape stubbles, pasture, waste ground, dunes and other farmland.

The geographical distribution of the 6 most important habitat types is shown in Figure 1. Saltmarsh appears to be primarily a feature of birds wintering on the shores of the Moray Firth, Firth of Forth, Argyll, Ayrshire and Dumfries and Galloway. Agricultural habitats have a more northerly bias. Although we did not specifically collect information on the

altitude at which habitats were situated, it is clear from Figure 1 that they were located in low lying areas relatively close to coasts, presumably because these are the areas least likely to suffer from frosts and prolonged snow cover. One or 2 of the survey forms returned noted a tendency for birds to disappear from agricultural habitats during periods of hard weather for instance in Caithness and Strathallan in SW Perthshire and to appear on the coasts at such times, for instance in Fife. Birds usually reappeared, very shortly after the weather improved and evidently did not move far. These fragmentary observations do suggest, however, that habitats only occasionally used may sometimes be important for the birds' survival in bad weather.

Foods

Table 2 presents a summary of the principal foods seen to be taken by Twites in Scotland in the winter months. However, many of the questionnaire returns noted a lack of information on foods, so Table 2 is undoubtedly incomplete. Several forms made reference to plants such as grasses, sedges, seaweed (*cf* Jardine 1992), Nettle *Urtica,* Chickweed *Cerastium* and Thrift *Armeria maritima,* used in the period April-October, and we think it likely that some of these may also be used in winter. The foodplants listed are, however, typical of those recorded elsewhere in the Twite's Western European range (*eg* Cramp & Perrins 1994), and reflect a diet based primarily on small seeds, especially those of the weeds of cultivation, and of various coastal plants.

Discussion

This study confirms the importance of agricultural habitats, especially turnip fields, rape and rape stubbles, other stubbles, pasture and other farmland as wintering areas for Twites in Scotland. With the exception of rape and rape stubbles, the common factor in these habitats is the presence of weeds. Saltmarsh, beaches and the strand line are also important, however, and others such as machair, dunes and waste ground are also used but in fewer places and mostly by only small numbers of birds. These findings are in contrast to the situation in England where saltmarsh is by far the most important habitat used in winter (Davies 1988) and we believe that they have important implications for the development of proper conservation measures for Twites in Scotland. Weedy turnip fields, in particular, are important in Scotland for a variety of other species including all such declining farmland birds as Grey Partridge *Perdix perdix,* Skylark *Alauda arvensis,* Song Thrush *Turdus philomelos,* Tree Sparrow *Passer montanus,* Linnet *Carduelis cannabina,* Reed Bunting *Emberiza schoeniclus* and Corn Bunting *Miliaria calandra* (M Hancock pers comm based on observations in NE Scotland, and our own unpublished data based on observations in Caithness, Sutherland and Easter Ross).

We have noted elsewhere declines by a factor of about 8 in the acreage of turnips in Caithness over the past half century, and similar trends in Sutherland (Clark & Sellers 1997a). It seems likely that the associated weed flora has decreased by at least the same amount and possibly more, given the widespread use of herbicides in recent decades. In Caithness, our observations suggest that only about a quarter of the current acreage of turnips contains enough weeds to be suitable for Twites. We suspect that the trends in turnip acreages in other parts of Scotland are similar, and this is also likely to be true of all the other weedy habitats.

TABLE 1 Habitat types used by Twites wintering in Scotland

Area	weedy turnip fields	rape & rape stubbles	other stubbles	pasture	other farmland	waste ground	machair	dunes	beaches & strand line	salt marsh	other
Shetland	3				3 [a]						
Fair Isle											1 [b]
Orkney	5	5	3			1			1		1
Caithness	5	5	2			3		2			
E Sutherland	4		3	4					1	1	2 [c]
N & W Sutherland	2			1	1		1	1			
E Ross, E Inverness	5	3	4	3		3			2	4	
Moray & Nairn	3							1		3	
NE Scotland	2	2				1		3	1	1	
Angus	4	1	1	1	3 [d]			1	1	3	
Fife			1		1	1			1	1	
SW Perthshire	5	5	5			4					
Inner Forth		2							4		
Lothian	4				1 [e]	4			1	4	1 [f]
Borders	1		1								1 [g]
Harris & Lewis			3	3			3		1		
Uists, Benbecula			4	2	3 [a]	3	4 [h]	3	1	3	3 [i]
Argyll (excl Bute)	4 [j]	4 [jk]	4	4			4 [l]	4	4	5	4 [m]
Central Strathclyde	3	3	3								
Arran, Bute, Cumbraes			3						3		
Ayrshire	5	2	5	4	5 [n]	4		1	4	2	4 [o]
Galloway	4		3	5				3	5	4	2 [p]
Dumfries-shire	2				4				1	4	
No. areas	17	10	15	9	8	9	4	9	15	12	9
No. areas with Abundance of 4 or 5	10	4	5	4	2	3	2	1	4	5	2

Table 1: footnotes

a	Potato fields and other cultivated land
b	Croftland and moorland
c	Birch woodland and moorland edge
d	Setaside
e	Rough grassland
f	Set aside and moorland
g	Moorland edge
h	Stubble
i	Moorland, roadsides and uninhabitated islands
j	Islay only
k	Fodder rape; all other entries in this column refer to oil seed rape. Fodder rape is grown as winter feed for stock and is grazed before it sets seed; Twites presumably feed on weeds associated with the fodder rape rather than the rape itself.
l	Often associated with cattle feeding areas
m	airfield (4), coastal grassland (4) and crofting land (4)
n	Potato fields
o	Short grass in beach parks
p	Around cattle feed troughs and silage rings

Abundance categories:

No entry	Habitats not used in winter (or none of this habitat in area)
1	Occurs irregularly in winter in small numbers (flocks <30 birds)
2	Occurs irregularly in winter in moderate numbers (flocks<100 birds)
3	Occurs regularly in winter in small numbers (flocks generally <30 birds)
4	Occurs regularly in winter in moderate numbers (flocks generally <100 birds)
5	Occurs regularly in winter in good numbers (flocks of >100 birds not uncommon)

Table 2 ***Principal foods taken by Twites in winter in Scotland***

Habitat	Principal foodplants etc
Turnip fields	Charlock *Sinapis arvensis,* Turnip *Brassica rapa,* Dock *Rumex,* weed seeds
Rape and Rape stubble	Rape *Brassica napus,* Charlock *Sinapis arvensis,*Dock *Rumex,* weed seeds (*cf* footnote k in Table 1)
Other stubbles	Barley, Oats, Linseed, Rye, Hay (all presumed to be food Plants) plus associated weeds including Dock *Rumex*
Pasture	Dock *Rumex,* Thistle *Carduus,* Knapweed *Centaurea,* Annual Meadowgrass *Poa annua*
Other farmland	Weeds in fields of sprouts, potatoes and set-aside
Waste ground	Dock *Rumex,* Thistle *Carduus,* Dandelion *Taraxacum* and other blown seed, weed seeds
Machair	Seeds of maritime flowers (Elliott 1989), Thistle *Carduus,* weed seeds
Dune systems	Marram *Ammophila arenaria, Chenopodium,* Black Knapweed *Centaurea nigra,* weed seeds
Beaches	Strand line (seeds and other detritus washed up by tide),Orache *Atriplex,* Groundsel *Senecio vulgaris, Chenopodium,* weed seeds
Saltmarsh	Glasswort *Salicornia,* Sea Aster *Aster tripolium*
Other	Birch *Betula,* weed seeds

The main mitigating factor in Caithness has been the recent introduction of oil seed rape as a crop and the strong preference that Twites have for it. The results presented here show that this is not unique to Caithness and that Twites have taken to using rape or rape stubbles in several parts of Scotland. To what extent rape has a role as a substitute for the weeds of turnip fields etc. remains to be resolved. In the short term the availability of subsidies for growing rape is likely to be the main factor determining the amount of rape that is grown; any reform of the EU Common Agricultural Policy should take into account the consequences for conservation of any changes in subsidies on this crop. The role of coastal habitats, especially saltmarsh and dunes, as a possible insurance against the non availability of agricultural habitats in hard weather merits further investigation. Protection of the remaining small areas of saltmarsh in Scotland is also a high priority.

Acknowledgements

This study would not have been possible without the patience and dedication of local bird recorders and other birdwatchers throughout Scotland and we are grateful to them all for their help. We thank also Ian Bainbridge and Mark Hancock of RSPB Scotland for their advice and support during the course of this work and their comments on an earlier draft of this report.

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Revised manuscript accepted August 1998

Wintering Twite *Mike Ashley*

Movements of Twites in Scotland

H CLARK & R M SELLERS

Scottish Twites undergo a complex set of movements between breeding and wintering quarters. Three migration routes, probably best described as partial migrations, are tentatively identified: (i) from Shetland through Fair Isle to Orkney probably extending south to Caithness, the Moray Firth and NE Scotland, (ii) from the NW Highlands and the Western Isles to Caithness, (iii) from the W Highlands through Argyll to the north coast of Ireland. The wintering areas of birds breeding in the Grampians, and the origins of birds wintering in southern Scotland remain unknown. The breeding populations of Caithness, and possibly those of E Sutherland, Easter Ross, Orkney, the southern islands of the Outer Hebrides and the southern islands of the Inner Hebrides appear to be resident throughout the year. There is no evidence that significant numbers of the Scandinavian race regularly reach Scotland. Conservation aspects of the results are discussed and the need for further studies highlighted.

Introduction

The Twite *Carduelis flavirostris* has a restricted breeding distribution in Western Europe, ranging discontinuously from the west and north coasts of Ireland through northern England and Scotland to western Norway and the Kola peninsula in northern Russia (Cramp & Perrins 1994, Hagemeijer & Blair 1997). The Norwegian population migrates south in the autumn mainly across the Skagerrak and through Denmark to winter along the coasts of northern France, the Low Countries and Germany (Bernhoft-Osa 1965). The movements of Twites in Britain are less well known. The small breeding population of the Peak District and southern Pennines moves to winter around southern North Sea coasts (Davies 1988); Scottish and Irish Twites, on the other hand, have been described as largely sedentary (eg Jardine & Reid 1993). This paper describes an analysis of what is known about the movements undertaken by Twites in Scotland.

Materials and Methods

The analysis draws on 4 main sources of information: a comparison of breeding and non breeding distributions, field observations of migrating birds, seasonal variations in numbers, and ringing recoveries.

The distribution of Twites in Britain and Ireland has been described as a result of surveys in 1968-72 (Sharrock 1976) and 1988-91 (Jardine & Reid 1993) for breeding birds, and in 1981-84 for wintering birds (Lack 1986). We supplemented these surveys with information obtained from a questionnaire

circulated to all local bird recorders in Scotland plus other knowledgeable birdwatchers with an interest in Twites (Clark & Sellers 1997a). The questionnaire asked for information on (i) timing of occurrence (especially where there was an appreciable difference in the numbers present between the breeding and non breeding seasons) and (ii) visible migration. The survey also solicited information on habitats, foods, numbers and changes in status; an analysis of these is published concurrently. Responses were received from all parts of Scotland except Wester Ross and west Inverness. We also checked relevant local avifaunas and bird reports. Information on Twites in Caithness came mainly from our earlier study (Clark & Sellers 1997b) and subsequent observations, and from records published in Caithness Birds, formerly the Caithness Bird Report.

Ringing recoveries for Twites marked in Scotland were kindly made available by the British Trust for Ornithology. The total number of recoveries available was 26; 12 recovered at the site of ringing in the same season provided no information on movements and were excluded from the analysis.

Results

Distributions in the breeding and non breeding seasons

When the distributions in the breeding and non breeding seasons are superimposed (Figure 1), it is evident that only a few areas hold birds throughout the year, chief amongst them being the Northern Isles (principally Orkney), Caithness, E Sutherland, SE Ross, E Inverness, the southern islands of the Outer Hebrides (Uists, Benbecula), the southern islands of the Inner Hebrides (Coll, Tiree, Colonsay, Oronsay and Islay) and W Galloway. By contrast a large part of the breeding range including Lewis, most of Skye, Mull, the NW Highlands from Cape Wrath to the Firth of Lorn, and N Perthshire is largely devoid of Twites in winter. Areas where birds appear only in the non breeding season include the coasts of Ayrshire, E Galloway, Lanarkshire, the inner Solway Firth, SW Perthshire, the shores of the Moray Firth south of the Dornoch Firth, Angus, Fife, inner Firth of Forth, coastal Lothian and the E Grampians.

Other observations

A summary of observations on the occurrence of migrating Twites in Scotland is given in Table 1. These show that in several of the areas identified as holding birds in both the breeding and non breeding seasons there is a substantial winter influx of birds. Included in this category are Caithness, E Sutherland, E Inverness, Islay and E Galloway. By contrast, there is a reduction in the numbers of birds in winter in Shetland. It appears that most movements occur in October-November and March-April.

The most detailed information on the passage of Twites comes from Fair Isle and North Ronaldsay, where regular observations have been made over many years. At the former, the main migration periods are August-October with a much smaller passage in April and May (Dymond 1991), whilst on North Ronaldsay there is a small autumn passage from mid August to early November but little evidence of a spring passage (K Woodbridge, *pers comm*). Migrant flocks have also been noted on the Isle of May, and what appear to be migrant flocks have been noted on both sides of the Pentland Firth, in E Sutherland, in several places on the west coast (Lewis, Eigg, Mull, mainland Argyll, Oronsay, Islay

Figure 1 Distribution of the Twite in Scotland in the breeding and non breeding seasons

and Arran) and the Gargunnock Hills (Stirlingshire). In addition, Twites are occasionally noted on oil and gas platforms in the North Sea, with the majority of such sightings coming from those in the Forties field off Aberdeen, although there are a few from the oil rigs off Shetland (Table 1).

A number of the replies to our questionnaire made reference to hard weather movements. For instance, Twites were reported as appearing in hard weather on the coasts of Fife and Ayrshire and as disappearing from SW Perthshire, perhaps connected with their appearance in Fife. We have noted similar behaviour in Caithness, with birds disappearing with the onset of snow cover and reappearing more or less immediately once a thaw was underway. We do not know where the birds went but evidently it was not far; it was probably nearby coasts, which at such times are likely to be the only places where Twites can find food. Coastal movements noted near Aberdeen and in Lothian may also be related to hard weather.

Table 1 ***Summary of sightings of migrating Twites in Scotland***

Area	Principal observations
North Sea Oil Platforms	Occasionally noted on spring and autumn passage; most records from oil rigs in the Forties field ca150km off Aberdeen, a few from those between Shetland and Norway (Bourne *et al* 1978, North Sea Bird Reports).
Shetland	Less common in winter than in breeding season (K Osborn, *pers. comm*) Large numbers on passage Unst, 26 September and 4 December 1911 (Baxter & Rintoul 1953).
Fair Isle	Fairly common as a breeding species; winters occasionally in small numbers (formerly wintered more regularly); distinct spring and autumn passage, April-May and August-October (Dymond 1991).
Orkney	Present all year, in strength late October – early May. Regular autumn passage noted on North Ronaldsay, but little evidence of spring passage (K Woodbridge, *pers comm*). Regular passage suspected, Pentland Skerries, 1880s (eg Harvie-Brown 1886). Large numbers on passage, Pentland Skerries, 12 October, 6 November and 6 December 1911 (Baxter & Rintoul 1953); flock of 40 on Pentland Skerries on 18 September 1976 may also have been on passage (Booth, Cuthbert & Reynolds 1984).
Sule Skerry	"...most commonly seen in April and May, sometimes in large flocks, which remain for a few day. Small numbers appear in August and September and occasionally in November" (Clark 1912).
Caithness	Much more common in winter than in the breeding season though varying somewhat between years (Clark & Sellers 1997b); present in strength in October-March. One record of flock of 250 birds coming in off sea at Duncansby Head in October 1995 and one record on Stroma probably relate to migrants.
NW Suther -land	Post-breeding flocks of up to 100 birds present mid August-September; irregular in winter months.
E Suther -land	Present throughout the year but more common in late October-March when confined to low ground. Small parties of birds seen moving west through Clynelish Valley, Brora, late February and early March.
E Ross, E Inverness	More common in the winter months, when occurs on low ground near coast. Flock of 40 flying south, possibly migrating, Buachaille Etive Beag, Lochaber, 15 September 1990 (Highland Bird Report 1990).
Moray & Nairn	A century ago good breeding and wintering numbers with apparent move ment from high ground to low ground and coast in winter. Numbers now much smaller but still mainly present on high ground in breeding season and low ground October-April (Cook 1992).
NE Scotland	Wintering numbers variable, but far exceed the breeding population in most years (Buckland *et al* 1990); higher numbers present early November – end February. On 24 December 1995 at Aberdeen Beach several hundred moving "along coast and swinging inland"; this exceptional record was thought to be the result of a hard weather movement.

Fife	Winter visitor in small numbers (Smout 1986); occurrence perhaps associated with hard weather (D E Dickson, *pers comm*). Single birds or small flocks seen from time to time on Isle of May mostly in October and March/April, often with Scandinavian migrants such as Brambling, Black Redstart, Lapland Bunting and Snow Bunting (I M Darling, *pers comm*). Thom (1986) says that "Some immigration is also believed to take place, as Twites are sometimes seen arriving on the east coast in autumn and parties of up to 50 have been recorded on the Isle of May in both autumn and spring"; we have not been able to corroborate this statement.
SW Perth -shire	Winter visitor in good numbers; present mid-October – early May, in strength early November – end February
Stirlingshire & Inner Firth of Forth	Winter visitor, present mid-October – early March, in strength NovemberFebruary. Flock of 25 flying west, Stronend, Gargunnock Hills, 25 October 1976 presumed to be migrants.
Lothian	Winter visitor (though breeds in very small numbers in the Pentland Hills), present early October – early May, in strength late October – early March. Small numbers noted occasionally moving west along the coast at Aberlady, Gosford and Musselburgh in October – December and March – April.
Borders	Winter visitor, present early December – late February.
Outer Hebrides	Present all year; irregular as a migrant (Cunningham, Dix & Snow 1995).
- Lewis	Large numbers noted on passage, Butt of Lewis, 24 September 1911 (Baxter & Rintoul 1953).
- Uists, Benbecula	Present all year; no obvious change in numbers.
- Flannan Is	Summer visitor (Clark 1912).
Inner Hebrides	
- Rhum	Influxes noted in April (Evans & Flower 1967).
- Eigg	Evidence of passage, *eg* flock of 150+ 18 August 1958 (Evans & Flower 1967).
- Coll & Tiree	Present throughout the year (Stroud 1989); on Coll present in strength August-April with some evidence of passage August/September.
- Iona & Mull	Present in small numbers throughout the year, irregular in winter months; migrants occasionally seen (Madders & Snow 1987); post-breeding flocks of up to 60 birds present August-September.
-Colonsay & Oronsay	Present throughout the year (Jardine, Clarke & Clarke 1986). Possible northward passage noted on Oronsay in April 1987 (Jardine 1992).
- Islay	Breeds in small numbers; more common in winter; passage evident (Elliott 1989, Ogilvie 1992).
Argyll (mainland)	Small numbers breed and overwinter; common in suitable habitat o passage (Madders, Snow & Welstead 1991).
C Strathclyde	Winter visitor in small numbers.
Arran, Bute, Cumbraes	Occasional winter visitor in small numbers, present August-March. Some evidence of passage on Arran where birds have been seen arriving from the sea (T ap Rheinallt, *pers comm*).

Ayrshire	Winter visitor (though a few breed on Ailsa Craig), present end September – early May, in strength mid-November – late March; highest numbers possibly associated with hard weather when occurs with Brambling, Chaffinch and Linnet. Movements often occur at same time as visible migration of Skylarks believed to originate from N and NW Scotland, and possibly from the continent.
Galloway	Small numbers breeding in E Galloway; influx in non-breeding season, present September – April, in strength October – March. Some evidence of a passage of birds in Wigtownshire (Dickson 1992).
Dumfriesshire	Winter visitor.

a Information from this study unless otherwise stated.

Ringing recoveries

Figure 2 shows the 10 recoveries of Scottish Twites involving movements of >40 km. There were 3 movements between Fair Isle (ringing dates September (2) and October) and Orkney where the birds were recovered in May, November and January respectively, and one movement between Shetland and Orkney. A bird ringed on Fair Isle in July 1990 was recovered near Ellon in NE Scotland in March 1992. Two movements were recorded between winter quarters in Caithness and breeding grounds in NW Scotland: one in Wester Ross and one in Lewis. There were 2 movements between W Scotland and Ireland, one in each direction, but involving birds breeding in Scotland and wintering in Ireland. A bird ringed on Fair Isle in July was found dying on a ship off the coast of Germany/ Denmark approximately 3 months later. These movements involved 4 males and 4 females of which 5 were first years and 3 adults, as well as 2 birds whose age or sex was not known.

There were, in addition, 4 short distance movements which show evidence of fidelity to an area throughout the year. These included a bird ringed on Out Skerries, Shetland in September and controlled the following February on Whalsay, Shetland (13 km SW), a bird ringed on Foula, Shetland in October and recovered dead in the following January on Wester Skeld, Shetland (35 km E), a first year female ringed at Lynegar, Caithness in January and found dead the following April at Dunbeath, Caithness (29 km W) and a first year male ringed at Northfield, Caithness in December and found tangled in sheep's wool at Hempriggs, Caithness, in June, 2.5 years later (2 km SSE).

Discussion

Movements

Even though the information available is incomplete, it is clear that a substantial part of the Scottish Twite population moves away from the breeding grounds for the winter

months, and, in general, there appears to be a shift from high to low ground. The pattern of movements is evidently complex and, on the basis of the evidence presented here, we believe that at least 3 distinct migratory routes can tentatively be identified as follows:

(1) from Shetland through Fair Isle to Orkney, and probably extending southwards to Caithness and the low lying coastal strip around the Moray Firth, especially around the Dornoch, Cromarty and Beauly Firths, and NE Scotland. In the main this probably involves birds breeding in Shetland, though we do not exclude the possibility that some birds from Norway are also involved;

(2) from the NW Highlands and the Western Isles to Caithness, and possibly to the coastal plain of E Sutherland, and by implication Easter Ross and E Inverness; and

(3) from the W Highlands through Argyll to the north coast of Ireland.

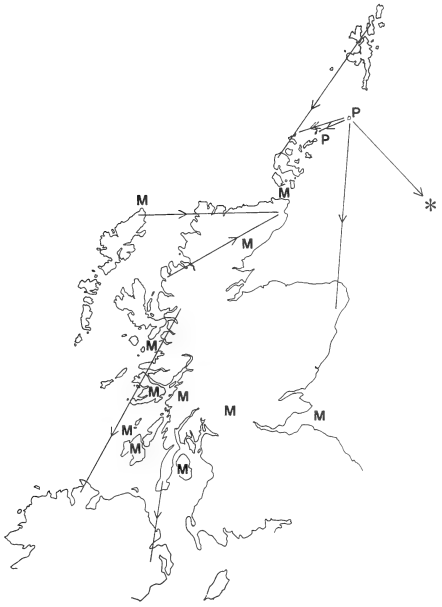
The wintering areas of birds breeding in the southern Grampians, and the breeding locations of birds wintering in southern Scotland remain unknown. Small numbers of Twites also winter in northern England and the Isle of Man, and we suspect that these are mostly of Scottish origin.

In parts of nearly all the breeding areas just listed, some birds appear to remain during the non breeding season for instance, on Shetland and Orkney, and the Outer and Inner Hebrides, and it may be better to describe all 3 as partial migrations. Birds breeding in Caithness, and probably those in E Sutherland and Easter Ross also, appear to remain close to their breeding grounds throughout the year, undertaking perhaps short distance movements from high to low ground, though we do not exclude the possibility that some migrate.

There is no direct evidence from ringing that birds from Norway winter in Britain. An extensive ringing programme was carried out in Norway in the 1960s and generated over 100 recoveries, mainly from the countries along the south eastern seaboard of the North Sea, but none from Scotland (Bernhoft-Osa 1965, Cramp & Perrins 1994). The occasional arrival of Twites at sites such as the Isle of May with known Scandinavian migrants suggests that some Norwegian birds do migrate into Britain and this is supported by the records of Twites from oil rigs in the North Sea, especially the northern ones. The sightings from the more southerly rigs are also probably birds from Norway, but it is possible that they are Scottish, probably Shetland, birds migrating to the continent; the bird ringed on Fair Isle and recovered off the German/Danish coast may be such a bird. We think it likely that small numbers of Scandinavian birds do appear in Scotland, but that there is no regular large scale movement across the northern North Sea.

We had hoped to shed further light on the question of whether Scandinavian Twites *C f flavirostris* visit Scotland by examining skins in the collection of the British Museum (Natural History) and some kindly obtained by them on our behalf from the University Zoological Museum, Oslo. In practice, we found the differences in plumage between the Scandinavian race *C f flavirostris* and that breeding in Britain (*C f pipilans*; the Outer Hebrides breeding population is sometimes treated as a separate sub species *C f bensonorum*) to be so slight that they could not be applied with confidence either to skins of wintering birds taken in Scotland or to birds caught in the field. The races also differ

Figure 2 ***Ringing recoveries of Twites in Scotland. Lines and arrows connect movements from breeding to winter quarters; these may not be the actual routes taken.***



*Bird recovered on a ship off the coast of Denmark/Germany
P Sites with a regular passage of Twites
M Sites where migrant flocks have been recorded

slightly in size with *C f flavirostris* the larger (Clark & Sellers unpublished data based on skins), but it also proved impossible to demonstrate conclusively on the wing measurements that any *flavirostris* occur in Britain.

Conservation aspects

The Twite is one of the few British breeding landbirds whose population is of international importance and its conservation is therefore of some importance. The prime conservation requirement is to provide protection to the

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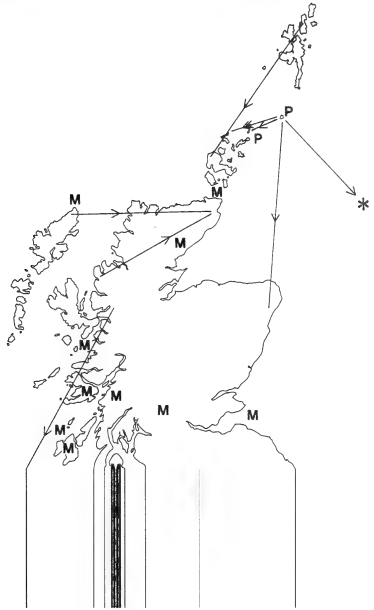

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main breeding and wintering areas (Batten *et al* 1990, Brown & Crockford 1997), but implicit in this is a sound knowledge of migration routes. The picture which emerges from this study is complex, but emphasises that any action to protect Twites in their principal wintering areas in Scotland (Orkney, Caithness, southern part of Western Isles, SW Perthshire, Argyll) must be balanced by equivalent action in the corresponding parts of the breeding range, namely Shetland, Orkney, Caithness, W and NW Scotland, Western Isles, and N Perthshire. Knowledge of the movements of Twites in Scotland is not complete and more information on this is needed to ensure the effective conservation of the species. This will probably be best achieved by a coordinated programme of ringing throughout Scotland.

Acknowledgements

This study would not have been possible without the help of a large number of people, many unknown to us, and to them all we extend our thanks. We owe a particular debt to the British Museum (Natural History), Tring and the University Zoological Museum, Oslo for permitting us to check Twite skins in their collections, to the Scottish Ornithologists' Club for providing help with obtaining local Scottish bird reports and other publications, to Fair Isle Bird Observatory and North Ronaldsay Bird Observatory for supplying information on the passage of Twites at their sites, and to local bird recorders throughout Scotland and other birdwatchers for their patience in answering our questions. Ringing recoveries were kindly made available through the BTO Ringing Scheme which is supported by the BTO, and the Joint Nature Conservation Committee (on behalf of the Countryside Council for Wales, the Department of the Environment (Northern Ireland), English Nature and Scottish Natural Heritage, the National Parks and Wildlife Service (Ireland), and the ringers themselves. We would also like to thank Paul Collin, Ian Darling, Angus Hogg, David Jardine, Kevin Osborn, Tristan ap Rheinallt, Alan Vittery, Audrey Walters and Kevin Woodbridge for their unstinting help and advice in our search for information on Twites in Scotland. Finally we are indebted to Ian Bainbridge. Mark Hancock and Baz Hughes for their comments on an earlier draft of this paper.

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Distribution and foraging habitat preferences of Choughs on The Oa peninsula, Islay

M MADDERS, F M LECKIE, J WATSON & C R MCKAY

Foraging Choughs on The Oa peninsula, Islay, were studied in relation to the distribution of habitat. A total of 13-14 birds were present in winter 1995, and 6 pairs and one subadult in late summer 1996. In general, foraging Choughs selected grassland habitats. In Decmber-February, the order of Chough foraging preferences was acidic grassland > improved grassland > neutral grassland > other habitats. In July-September, when Choughs were distributed mostly around the coast, the order was neutral (dune) grassland > cliff and slope > acidic grassland and other habitats. Decline in the number of Choughs on The Oa does not appear to be associated with change in the availability of preferred foraging habitats. Other factors that may have had an adverse effect on Chough populations are discussed, and areas of further research identified.

Introduction

The Isle of Islay has traditionally supported a large number of breeding Choughs *Pyrrhocorax pyrrhocorax* (Thom 1986). A survey in 1986 estimated that the Scottish Chough population comprised at least 105 pairs, of which 95 (90%) were on Islay (Monaghan *et al* 1989). Increases in the Islay Chough population between 1968-72 and 1988-91 have been attributed to stable land management and the conservation of nest sites (Gibbons *et al* 1993). However, evidence from The Oa peninsula on Islay suggests that numbers of chough have declined dramatically in recent years. Breeding surveys found 19 pairs and 22 non breeders on The Oa in 1982 (Warnes 1983), and 23 pairs and 20 non breeders in 1986 (Monaghan et al 1989). These surveys indicated that The Oa held 31% and 24%, respectively, of the Islay breeding population. By 1992 only 13 pairs were present on The Oa (E. Bignal *pers comm*), representing 18% of the total number of pairs on Islay. A partial survey in 1994 indicated that The Oa breeding population had further declined to 7 pairs (Bignal 1994).

Few data are available on the size of the wintering population on The Oa. Warnes (1983) reported that 42 Choughs were located during a coastal survey in December 1980, and considered that a further 15 birds found on the Laggan peninsula at the same time were part of The Oa population. More recently, observations of Choughs foraging inland indicated that a minimum of 23 birds were present during winter 1987 (C R McKay *pers comm*).

In order to better understand the factors that influence Chough populations, we studied the distribution of Choughs on The Oa in relation to the availability of habitat. Definitions follow those of Mosher *et al* (1987). *Availability*

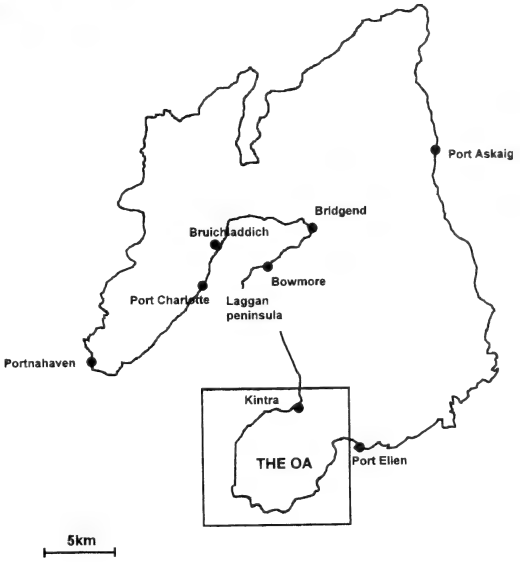
of a habitat is its relative area within the study area. *Habitat use* is a measure of the quantity of a habitat utilised. *Habitat selection* occurs when a habitat is used disproportionately in relation to its availability. *Preference* for a habitat is a measure of the likelihood of that habitat being chosen if its availability is equal with that of other habitats.

Study area

The Oa is a broad peninsula covering approximately 47km^2 in the southwest of Islay (Figure 1). A wide range of habitats are supported, including bog and dwarf shrub heath, semi improved acid and neutral grasslands, and improved and semi improved pastures and arable habitats. The coast comprises mainly steep rocky cliffs in the west and south, and lower profile cliffs and raised beaches in the east. An extensive dune system adjoins the area at Kintra, and extends northwards to the Laggan peninsula. The Oa is extremely exposed and generally treeless, although some of the eastern part was planted with conifers during the 1980s.

Land use is geared mainly to the production of beef cattle and sheep. The inbye pastures and semi improved grasslands are used

Figure 1 ***Location of The Oa, Islay***

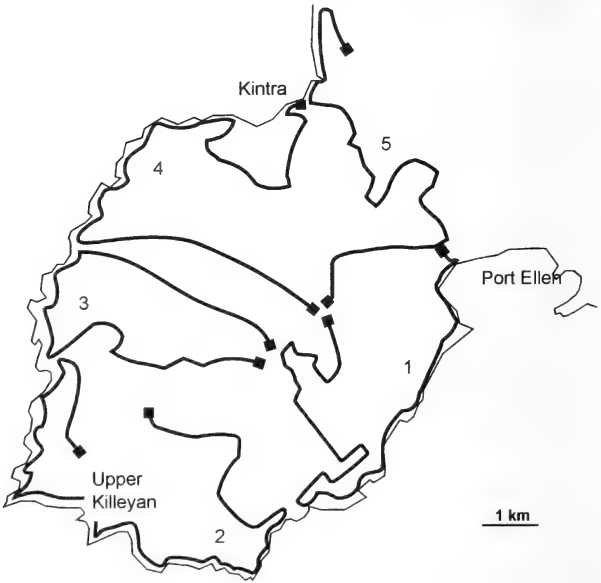


mostly for grazing in spring and silage production in summer. Most improved grass is left ungrazed by cattle during winter to avoid poaching, except at Kintra where the ground is better drained as a result of the sandy substrate. Elsewhere, the semi improved grasslands and heath/grassland mosaics are extensively grazed by sheep and small numbers of cattle throughout the year. The coastal cliffs are grazed by a population of c.100-150 feral goats (Newton 1984). Rabbits Oryctolagus cuniculus occur in several localities, and are particularly numerous in the dune grassland at Kintra.

Methods

Chough distribution and behaviour were recorded during 2 study periods: December-February 1995-6 and July-September 1996. Five survey routes were used to systematically search for Choughs on The Oa and in a buffer zone extending approximately 1km east. Routes were selected to pass within 0.5km of all areas of habitat considered likely to hold Choughs, ie sea cliffs and slopes, grassland, and cultivated ground (Figure

Figure 2 ***Location of 5 routes used to systematically survey Choughs on The Oa, Islay.***



2). Routes were allowed to meander so that suitable ground could be covered as thoroughly as possible. Where routes followed the coast, headlands were used to carefully scan the seacliff and shoreline. The total area visible from all routes was estimated to be 40 km^2, ie 85% of the study area.

Each route was walked 12 times (6 times each in December-February and July-September). The direction in which routes were undertaken was reversed between visits, to help control for diurnal variation in Chough activity. Possible bias due to differences in Chough detection between different observers was minimised by ensuring that each observer undertook each route an equal number of times. Observations were carried out only in conditions of good visibility, and in wind speeds <14 ms^{-1} (Beaufort scale 6).

All Choughs detected from the routes were recorded. To reduce dependency within the data, individuals considered to have been seen previously from the same route on the same day were excluded. These decisions were based on observations of Chough movements and, in a small number of cases, from observations of uniquely colour ringed individuals. Locations at which Choughs were initially detected were plotted onto 1:10,000 scale maps and the habitat at each location classified by reference to Phase 1 (NCC 1990) habitat maps drawn in 1995. For each observation, the number of Choughs were recorded, and the activity of each bird classified as foraging or not. Where possible, each bird was checked for colour rings and aged as either adult, sub adult (at least one calendar year old), or juvenile/immature.

The area of each available habitat class was estimated using a point sampling technique. Points were selected by overlaying Phase 1 habitat maps with a grid, the cells of which represented 200x200m on the ground. Preliminary analysis indicated that, up to 200m from the route surveyed, the frequency with which Choughs were detected did not decline with distance. However, numbers declined rapidly beyond this distance, such that only 33% of the total observations related to Choughs located greater than 200m away (n = 24). Ideally, we would have liked to determine habitat selection using only data from points 0-200m from survey routes. However, this would have resulted in unacceptably small sample sizes, and would have reduced both the areas and range of the habitats sampled. Accordingly, habitat was classified at all grid intersections within 200m of the survey routes, and at a random sample of 50% of the other available intersections within 1km. Intersections were used regardless of whether they had been classified for other routes. Using this approach, the distribution of habitat sampling points reflected bias in the locations of the Choughs observed. Grid intersections that fell within areas of sea were ignored. The availability of each habitat was determined simply by counting the number of sample points within each habitat class.

Foraging habitat preferences were investigated by comparing selection probability functions (Manly et al 1993) for habitats in which Choughs were observed to feed. These functions represent the proportion of the available units in a particular habitat class that are used. In this case, they can be estimated by dividing the proportion of Chough foraging observations in a particular habitat class by the proportion of that habitat class observed, ie

$$w_i = (u_i / u_+) / (a_i / a_+)$$

where w_i is the sample selection ratio, u_i is the number of records of foraging Choughs in habitat class i, u_+ is the total number of

records of foraging Choughs, a_i is the area of habitat class i observed, and $\hat{a}_i$ is the total area of all habitat classes observed. Selection functions were standardised so that they summed to one. These standardised ratios (B_i) can be interpreted as being the estimated probability that a habitat would be the next one selected if each class could be made equally available to a foraging Chough. Possible values for B_i can range from 0 (no selection) to 1 (always selected).

Results

Numbers and distribution

Choughs were observed 68 times (29 times in December-February and 39 times in July-September). Each observation involved between one and 13 birds. The distribution of sightings differed markedly between seasons, with more birds encountered around the western coast during July-September, and greater use of inland pastures in December-February (Figure 3). This shift away from coastal habitats in winter was statistically highly significant (mean distance from High Water Mark in metres ± Standard Error: July-September 325.6 ± 62.7, n = 39; December-February 967.2 ± 114.4, n = 29; t = -5.24, df 66, 2-tailed $P < 0.001$).

Based on simultaneous sightings of Choughs in different localities, together with observations of 2 colour ringed individuals, The Oa wintering population in 1995/6 was estimated to comprise 13-14 birds, including at least 4 adult pairs. Excluding juveniles, a total of thirteen Choughs was present during July-September 1996, including 6 adult pairs and a sub adult. In July, 5 pairs were accompanied a total of 10 fledged young. However, one juvenile had disappeared by September. One family moved to the adjoining duneland north of Kintra shortly after fledging, and did not return to The Oa until September. The remaining birds mostly occupied the south western cliffs and adjacent pastures, where they often coalesced into a single foraging group.

Habitat selection

Fifty Chough observations involved one or more foraging individual (December-February: 24; July-September: 26). Foraging Choughs occupied 10 Phase 1 habitat classes, comprising 5 grassland and 2 heathland types, plus cliff and slope, arable, and inter tidal habitats (Table 1). A further 7 habitat classes available on The Oa were avoided by Choughs. These included woodland and scrub, marshy grassland, bracken, and mires and flushes. The only area of arable habitat selected was a stubble field at Upper Killeyan, which was used by varying numbers of Choughs after it was cut in late August. Choughs feeding in this field appeared to forage for invertebrates within the soil rather than on any residual grain. Overall, Choughs preferred semi improved to unimproved acidic grassland. Wintering Choughs foraged preferentially in acidic grassland and improved grassland (Figure 4). Neutral grasslands were less preferred, and other habitats were used little or not at all. In July-September, Choughs showed a strong preference for neutral grasslands, followed by maritime cliff/slope and acidic grasslands. Other habitats used by Choughs included arable and inter tidal habitats (July-September only), and dwarf shrub heaths.

According to the Phase 1 vegetation maps Choughs foraged in wet and dry heaths during both study periods. However, field observations indicated that Choughs were in fact using small patches of unimproved

Figure 3 ***Sites where Choughs were initially located during systematic coverage of survey routes. Dot size represents the number of Choughs in each group located (including juveniles). Arrows show the direction and number of flying birds.***
(a) December-February
(b) July -September

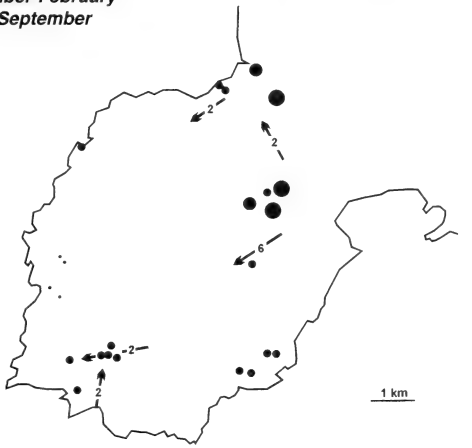


Figure 3a

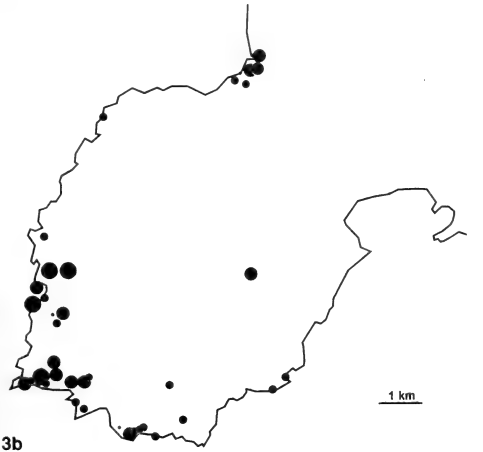


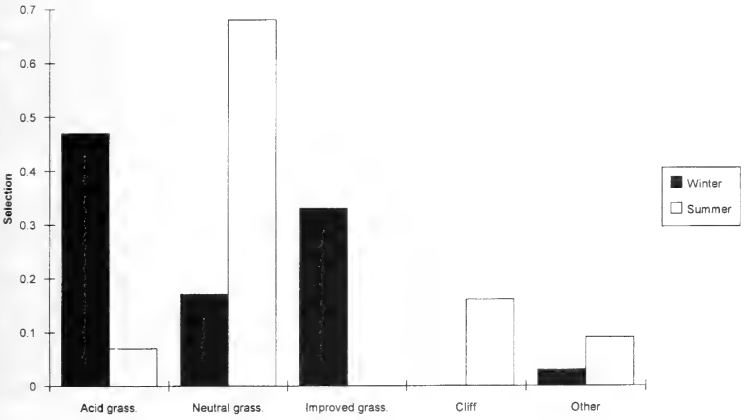
Figure 3b

Table 1 ***Availability of Phase 1 habitat classes on The Oa and their selection by foraging Choughs.***

Phase 1 habitat class	Habitat Available		Habitat selected							
			Dec-Feb				Jul-Sept			
	a_i	a/a_+	u_i	u/u_+	w_i	B_i	u_i	u/u_+	w_i	B_i
Woodland & scrub	37	.040	0	-	-	-	0	-	-	-
Acidic grassland										
Semi improved	12	.013	3	.125	9.61	**.44**	1	.038	2.92	**.05**
Unimproved	57	.062	1	.042	.68	**.03**	2	.077	1.24	**.02**
Neutral grassland										
Semi improved	124	.134	12	.500	3.73	**.17**	7	.269	2.01	**.03**
Unimproved	4	.004	0	-	-	-	0	-	-	-
Calcaraeous grassland										
Unimproved	8	.009	0	-	-	-	0	-	-	-
Improved grassland	27	.029	5	.208	7.17	**.33**	0	-	-	-
Marshy grassland	63	.068	0	-	-	-	0	-	-	-
Bracken	21	.023	0	-	-	-	0	-	-	-
Dry dwarf shrub heath	125	.135	1	.042	.31	**.01**	4	.154	1.14	**.02**
Wet dwarf shrub heath	213	.230	2	.083	.36	**.02**	4	.154	.67	**.01**
Mires & flushes	168	.182	0	-	-	-	0	-	-	-
Lochs	9	.009	0	-	-	-	0	-	-	-
Coastal grassland	3	.003	0	-	-	-	3	.115	38.33	**.65**
Cliff	12	.012	0	-	-	-	3	.115	9.58	**.16**
Arable land	21	.023	0	-	-	-	1	.038	1.65	**.03**
Unclassified										
Inter tidal	21	.023	0	-	-	-	1	.038	1.65	**.03**

Key: a_i = number of sampling points in habitat class i; a = total number of sampling points (Σa = 925); a/a_+ = habitat class i as a proportion of total habitat classes; U_i = number of records of foraging Choughs in habitat class i; u = total number of records of foraging Choughs (Dec-Feb: Σu = 24; Jul-Sept: Σu = 26); u/u_+ = number of records of foraging Choughs in habitat class i as a proportion of total number of records of foraging Choughs; w_i = selection ration; B'_i = standardised selection ration.

Figure 4 ***Habitat preferences of foraging Choughs in Jul-Sept and Dec-Feb. The graph shows standardised selection indices for 5 Phase 1 habitat groupings (semi improved and improved acidic grasslands combined; coastal and semi improved neutral grasslands combined; other = wet and dry heaths, arable land and inter tidal habitats).***



grassland within heathland habitats. These were presumably too small to be discriminated by the Phase 1 mapping resolution. It was notable that many of these patches were located in areas overlying bands of limestone.

Discussion

Comparison with data from the 1980s (Warnes 1983; Monaghan et al 1989) indicates that The Oa breeding population has decreased by about 75% and the wintering population by about 60%, a serious long term decline. Warnes (1982) considered that approximately 30% of The Oa population wintered on the Laggan peninsula. We found no evidence to suggest that this is currently the case, although one family group from The Oa took up temporary residence in duneland south of Laggan during late summer.

Important differences in habitat selection by foraging Choughs were apparent between the 2 study periods. Choughs used a wider range of habitats in July-September, and were less reliant on improved grasslands and semi-improved acidic grasslands. This is consistent with McKay (1996), who found that Choughs on the Rinns of Islay used the narrowest range of habitats in late winter, when most birds fed in improved or semi-improved pasture. Chough nest sites on The

Oa are mostly coastal (Warnes 1982), and increased preference for maritime cliff/slope habitat in the breeding season (April-July) is perhaps unsurprising. However, examination of the data shows that this habitat was much used as late as September. This suggests that Choughs' preference for cliff and slope habitat at this time may have been more than simply an artefact of nest site selection.

Neutral grasslands were the most preferred habitat in July-September. By far the most intensively used area of this habitat was the dune grassland at Kintra, where 4-6 Choughs were more-or-less resident during September. It is probable that these birds found the short grassy swards, grazed by cattle and rabbits, preferable to the more structured vegetation characteristic of many other grasslands at this time (see Bullock *et al* 1983). Most improved and enclosed semi improved pastures, for example, were effectively unavailable to Choughs much before August because they were used for silage crops.

We can think of no dramatic change in the availability of preferred foraging habitats on The Oa over the past decade, although it is accepted that insidious change (eg the spread of bracken) is difficult to detect and that there is a clear need for a proper historical review, perhaps by mapping habitats from aerial photographs. Farming practices are likely to have had an important effect on Choughs. Several case studies (Bullock *et al* 1983) have demonstrated the importance of grazing herbivores to Chough feeding ecology. These maintain the sward at a height short enough to allow Choughs access to soil invertebrates (Bullock 1980), while dung beetles *Aphodius* found in the faeces of cattle and sheep represent an important additional source of prey (Bullock *et al* 1983). We do not know how numbers of grazing livestock have changed on The Oa, and suggest that this would be a useful area for further investigation.

Improved animal husbandry may have had an adverse effect on Choughs. An increasing number of cattle are wintered indoors on The Oa, and this will have inevitably led to a reduction in the availability of cow dung. At the same time, the trend toward the supplementary feeding of those animals wintered outdoors is likely to have concentrated dung in fewer areas. Finally, there is concern over the use of the anthelminthic drug, Ivermectin, which may prevent invasion of dung by invertebrates (McCracken & Foster 1992).

Other factors which may have had an effect on Chough numbers, such as nest site availability and numbers of potential predators, are not known to have changed. The Oa holds a relatively strong population (10 pairs) of breeding Raven *Corvus corax* (Madders 1997). It is not known whether Raven numbers have increased in recent years, or if such an increase could have been detrimental to Choughs.

The Chough's decline on The Oa may be linked to changes in the population as a whole. A survey in 1992 (Bignal *unpublished)* indicated that numbers on Islay had declined by 35% since 1986, and that decline was greatest in the non breeding population. Our results indicate that a further widespread decline may have occurred, and the results of an island wide survey in 1998 are awaited with interest.

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Ross Lilley, Fiona Rout and Anthony Williams assisted with various aspects of the study. We thank Paul Thompson and an anonymous referee for their valuable comments on the manuscript. Fieldwork was carried out under contract to Scottish Natural Heritage.

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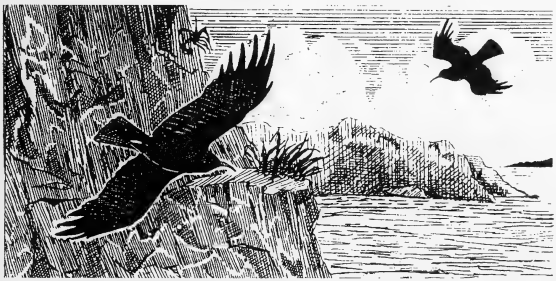


Choughs *Steven Brown*

Orkney Hen Harriers: a major population decline in the absence of persecution

E R MEEK, G W REBECCA, B RIBBANDS & K FAIRCLOUGH

The numbers of breeding male and female Hen Harriers in Orkney's West Mainland in 1996 and 1997 were estimated to have declined by about two thirds since their peaks in the 1970s. For the whole of Orkney during 1996 and 1997, 25% of the females which built nests apparently did not lay eggs. Of the nests located with eggs, 60% did not produce any fledged young. A maximum of 39 young were fledged over the 2 years giving a productivity range of 0.4 young per female, 0.6 young per nest built or 0.9 young per nest with eggs. This represented a decline of about two thirds in breeding production since the peaks in the early and mid 1970s. It is suggested that reduced food availability, associated with land use change, and avian predation may have been the main reasons for the change in status.

Introduction

The Hen Harrier *Circus cyaneus* population of the West Mainland of Orkney (Figure 1) has been well documented (Balfour 1957, 1962, 1963, Balfour & Cadbury 1975, 1979, Picozzi 1980, 1984a,b). Orkney was one of the species' few refuges from persecution in Britain during the late 19th and early 20th centuries and it is possible that the islands provided a source from which mainland Scotland was recolonised when gamekeeping pressure was relaxed during and immediately after World War II (1939-1945) (Watson 1977). More recently, it has been confirmed that Hen Harriers reared in Orkney have bred on mainland Scotland (Balfour & Cadbury 1975, Picozzi & Watson 1985).

Hen Harriers have suffered severe persecution over much of mainland Britain for most of the 20th century (Watson 1977, Bibby & Etheridge 1993, Etheridge *et al* 1997, Redpath & Thirgood 1997, Scottish Raptor Study Groups 1997, Potts 1998, Stott 1998). The Orkney Islands are unusual in Britain in that human persecution of Hen Harriers is virtually non existent and there are no Red Foxes *Vulpes vulpes,* one of the species' main natural predators (Watson 1977, Berry 1985, Redpath & Thirgood 1997).

The Orkney Hen Harrier population increased between the late 1940s and the mid 1970s by which time polygynous breeding was widespread in the West Mainland (Balfour & Cadbury 1979). In 1978, an exceptional year, 95 females nested in the West Mainland and it was also estimated that there were 43 breeding males (Picozzi 1984a,b, Table 1). Breeding also occurred in the 1970s on Rousay (5 to 8 nests), Hoy (4 nests), East Mainland (3 to 4 nests) and Eday (1 to 2 nests) (Balfour & Cadbury 1975, M Cockram, N Picozzi & E J Williams *pers comm*). The total number of breeding females for the whole of Orkney in 1978 may therefore have exceeded 110. Polygyny has also been recorded on Rousay and in the East Mainland but not on Hoy or Eday (RSPB unpublished, M Cockram, T Prescott & J Plowman *pers comm*). Thus, the total number of breeding males for the whole of Orkney in 1978 was probably between 51 and 55.

Figure 1 ***Map of the Orkney Islands, north Scotland***

In 1981, 57 female and 21 male Hen Harriers were found on West Mainland (Picozzi 1984a,b). Thereafter (apart from 1989) it became impractical to establish the annual number of harriers attempting to breed, mainly because of a lack of full time field study. However, it is believed that most, probably all, successful nests were found in the whole of Orkney for the period 1982-95 (RSPB unpublished). In 1989 a concentrated effort was made to locate all breeding attempts as part of a national Hen Harrier survey (Downing 1990, Bibby & Etheridge 1993) and a total of 71 breeding females was found, with 62 in the West Mainland (Table 1). The West Mainland figure was within the range found during Picozzi's intensive study and did not cause immediate concern. However, by 1994, it was evident that the decline had continued, possibly as a result of increasing nest failure and declining clutch size during 1982-94 (Kalejta-Summers 1995).

In 1996 and 1997 the Royal Society for the Protection of Birds attempted to census the Orkney Hen Harrier population and record breeding success, allowing comparisons to be made with the earlier studies of Balfour & Cadbury (1975, 1979), Picozzi (1984a,b) and Downing (1990).

Methods

In 1996 and 1997 all known nesting areas and other suitable moorland habitat in the West Mainland, Rousay, Hoy and Eday were visited and/or watched on several occasions between mid April and the end of May. The

Table 1 ***The numbers of breeding Hen Harriers in West Mainland, Orkney in years when all breeding attempts were thought to have been known.***

Year	Females	Males	Source
1970	42	16	Balfour & Cadbury
1979			
1971	44	21	"
1972	49	24	"
1973	51	36	"
1974	62	45	"
1975	47		Picozzi 1984 a,b
1976	56		"
1977	85	44	"
1978	95	43	"
1979	60	32	"
1980	80	27	"
1981	57	21	"
1989	62		Dowing 1990
1996	24	14	present study
1997	26	14	"

East Mainland now has little suitable moorland (Bennett 1986) and was only visited once in each breeding season. The initial fieldwork coincided with the courtship, pairing, nest building and peak egg laying periods when Hen Harriers are at their most obvious on the breeding grounds (Balfour 1957, 1963, Watson 1977). In addition, 6 transects of 7-8 km were each walked on 4 occasions during 15 April to 15 May in both years. Five were on West Mainland and one was on Rousay and they were designed so as to traverse blocks of moorland with recent records of breeding Hen Harriers. Further visits were made between mid May and early August to survey suitable habitat again, visit nests and record breeding success.

A breeding female was defined as one which built at least a partial nest, whether or not eggs were proven to have been laid. A non breeding female was defined as one which was not observed nest building. For example, if we regularly saw the females of a polygynous group of 3 (see Balfour & Cadbury 1979 and Picozzi 1984a,b) between mid April and the end of May and only found or saw 2 nests being built, the third female was classed as a non breeder. As there was limited time available for lengthy observations we could have underestimated the number of females that built nests. Accurate assessment of the number of adult males was difficult as none were individually marked (see Balfour & Cadbury 1979 & Picozzi 1984a,b for

Figure 2 ***The number of fledged or almost fledged young Hen Harriers in the West Mainland, Orkney between 1953 and 1997. Data from 1953-74 is from Picozzi (1980) and is a minimum count for some years as some broods were omitted from his analysis. Data from 1975-95 is the annual total of fledged young (Picozzi 1984a for 1975-81 and RSPB unpublished for 1982-95).***

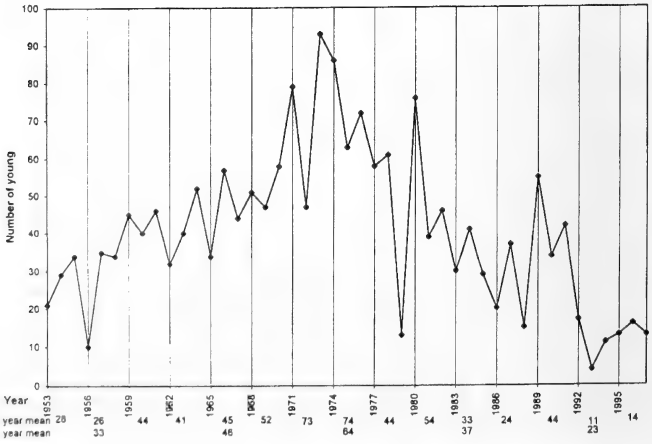
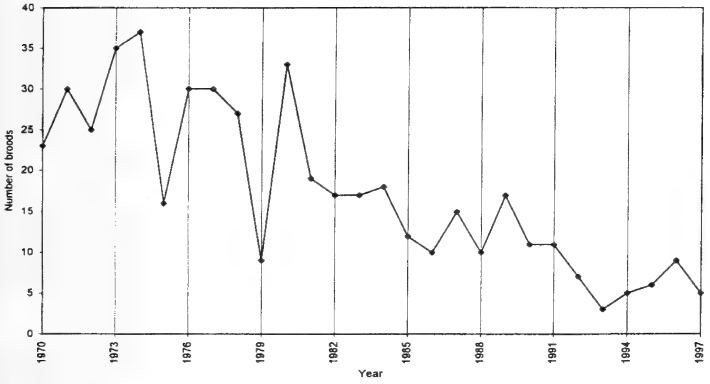


Figure 3 ***The number of broods of Hen Harriers with at least one fledged or almost fledged young in the West Mainland, Orkney between 1970 and 1997, years in which all successful nests are likely to have been located. Data from 1970-73 from Kalejta-Summers (1995), 1974 from C J Cadbury (in litt), 1975-81 from Picozzi (1984a) and 1982-95 from RSPB (unpublished).***



descriptions of marked birds). In addition, the members of a male's polygynous group of females may not necessarily have all been in the same valley, and therefore not all simultaneously visible to an individual observer. Our estimated figures for males were quantified using plumage characteristics and behavioural traits, together with close comparison of the timing of sightings in different areas by individual observers.

To measure breeding success we aimed to visit all nests at least once during the incubation, nestling and fledging stages. If the number of fledged young actually counted was less than the brood size at ringing, at about 3 weeks old, (i.e. the maximum number) we searched the nest and its environs for the remains of chicks. Mortality in the late nestling period is known to be low for Orkney harriers (Picozzi 1980), and when it does occur, remains are found (ERM *pers obs*). Therefore if no remains were found we presumed that the complete brood had fledged and these maximum figures were used to calculate productivity.

Results

Numbers

There were 29 and 31 breeding females respectively and 19 breeding males in Orkney in 1996 and 1997 (Table 2). Between the 2 years there was, however, a marked reduction in apparently non breeding females from 19 to 6, giving an overall total for females of 48 and 37 respectively (Table 2). In the West

Table 2 ***The estimated numbers of breeding Hen Harriers and non breeding females in Orkney in 1996 and 1997.***

Island	Females			Males	
	breeding	non breeding	totals	adults	first year
1996					
West Mainland	24	16	40	12	2
Eday	0	0	-	0	0
Rousay	1	1	2	1	0
Hoy	4	2	6	3	1
Totals	29	19	48	16	3
1997					
West Mainland	26	5	31	13	1
Eday	0	0	-	0	0
Rousay	1	1	2	1	0
Hoy	4	0	4	4	0
Totals	31	6	37	18	1

Mainland, the numbers of breeding females in 1996 and 1997 were 24 and 26 respectively, mean 25; males numbered 14 in each year (Tables 1, 2 & 4).

Breeding success

The breeding success in 1996 and 1997 is detailed in Table 3. The percentage of females building, at least partial nests, but apparently not subsequently laying eggs, was 17% in 1996 and 32% in 1997. In total, 45 nests with eggs were located, 24 in 1996 and 21 in 1997. Of these, 9 failed during incubation in 1996 and 13 in 1997. Five complete broods were lost, 4 in 1996 and 1 in 1997. Overall, 40% of nests found with eggs fledged at least one young. The total numbers of young believed to have fledged were 22 in 1996 and 17 in 1997. The maximum productivity of both years combined was 0.9 young per nest located with eggs, 0.6 young per nest built or 0.4 young per female (Table 3). In the 4 study periods where realistic comparisons could be made (1970-74, 1975-81, 1989 and 1996-97) there were significant differences between studies in the numbers of breeeding females and the production of young, ANOVA for breeding females, $F_{3,11}=5.51$, $p<0.02$ and for young per breeding female, $F_{3,11}=5.12$, $p<0.02$ Females averaged 68.6 during 1975-81 but had dropped to 25 by 1996-97. Average productivity was 1.5 young per breeding female in 1970-74 but had dropped to 0.6 by 1996-97 (Table 4). Interestingly, 1975-81 was the study period with the highest mean number of breeding females and was preceded by the highest period of mean productivity, 1970-74 (Table 4).

The estimated numbers of Hen Harriers reared annually in the West Mainland between 1953 and 1997 are shown in Figure 2. Since 1992, the numbers of fledged young have

Table 3 ***Breeding statistics for Hen Harriers In Orkney in 1996 and 1997. Female numbers from Table 2, NB = nest at least partially built, NE = nest with eggs.***

Island	Number of nests located	Nests with eggs	Nests with young	Nests with fledged young	Minimum & maximum no. of fledged young	Productivity maximum no. of fledged young per Female	NB	NE
1996								
West Mainland	24	19	12	9	13-16			
Rousay	1	1	1	1	1			
Hoy	4	4	2	1	5			
Total	29	24	15	11	19-22	0.4	0.7	0.9
1997								
West Mainland	26	16	5	5	9-13			
Rousay	1	1	1	0	0			
Hoy	4	4	2	2	4			
Total	31	21	8	7	13-17	0.4	0.5	0.8
1996 & 1997 combined	60	45	23	18	32-39	0.4	0.6	0.9

Table 4 ***Differences between studies in the numbers of breeding female Hen Harriers and in the production of young on West Mainland, Orkney (+/- = standard error).***

Studies	Years	Mean no of females	Mean no of fledged young/ mean no of breeding females
Balfour & Cadbury 1979 & Picozzi 1980	1970-74	49.6 (+/-6.3)	1.5 (+/-0.2)
Picozzi 1984a	1975-81	68.6 (+/-5.3)	0.8 (+/-0.1)
Downing 1990 & Kalejta-Summers 1995	1989	62	0.9
Present study	1996-97	25	0.6

been consistently low and in the worst year, 1993, only 4 were found. The 3 year means for 1992-94 and 1995-97 and the 9 year mean for 1989-97 were the lowest since records began in the 1950s (Figure 2). Figure 3 shows the number of broods fledged in the West Mainland between 1970 and 1997, years in which all successful nests were believed to have been located. The pattern is similar to Figure 2.

Discussion

Numbers and breeding success

The surveys in 1996 and 1997 were considered to have thoroughly covered all Hen Harrier breeding habitat except in the East Mainland. The latter area did support at least 6 breeding females in the late 1960s (E J Williams *pers comm*) but has lost so much suitable breeding habitat (Bennett 1986) that no more than one pair of harriers is believed to breed there now (ERM *pers obs*).

Search effort in the West Mainland is believed to have been comparable in each of the 4 main study periods (Table 4). This being the case, there has clearly been a major decline since the 1970s and the population in 1996-97 was very low. In order to avoid over emphasising the decline from the exceptional peak year of 1978, 3 year running means were calculated for the number of breeding females between 1970 and 1981. The peak 3 year running mean was in 1977-79 with 80 females, the 1996-97 mean of 25 representing a 69% decline. Three year running means cannot be calculated for males as data are lacking for 1975 and 1976. However, the mean for the 3 peak years for which data are available (1974, 1977 and 1978) was 44 (Table 1). The 1996-97 mean of 14 males represents a 68% decline .

In our study breeding success was poor, with a maximum of 39 young fledged for the whole of Orkney over the 2 years. In the West Mainland, the mean number of young fledged between 1992 and 1997 was only 12.3 +/- 4.6 s.d.; range 4 to 17. Previous poor years in the West Mainland (eg 1979 which was particularly wet) were usually followed by a marked improvement, but the period 1992-97 has been the least productive, in terms of young fledged, since detailed records began in 1953 (Figure 2). Three year running means of the number of young reared and the number of young reared per breeding female were calculated for 1970-81. The peak 3 year running mean for young reared was in 1973-75 at 80.7; the mean maximum figure for 1996-97 was 14.5, representing a decline of 82%. The 3 year running means for the number of young reared per breeding female peaked in 1971-73 and 1973-75 at 1.5; by 1996-97 productivity had fallen to 0.6, a 60% decline.

These declines, for breeders and production, since the peaks in the 1970s, are in the order of two thirds. In contrast to many other areas of Britain (Etheridge *et al* 1997, Stott 1998) they have occurred in the virtual absence of human persecution, at least when the birds are in Orkney.

Possible reasons for the declines

There has been major moorland reclamation on Orkney since 1932 (Bennett 1986); for example there was at least 40% moorland loss on the Mainland between 1940 and 1985 (Gorman & Reynolds 1993). However, in the West Mainland, no Hen Harrier nest sites have been lost to reclamation since Picozzi's study. Most of the core moorland areas, where the majority of the harriers nest, are Sites of Special Scientific Interest (SSSIs) where Scottish Natural Heritage have negotiated management agreements with landowners to restrict the stocking levels. Nevertheless, some of these areas are still grazed heavily enough to be degrading the areas of rank vegetation in which harriers prefer to nest. On the moorland fringes outwith the SSSIs, there are no restrictions on stocking densities and it is these areas, which in the past were some of the preferred

hunting areas of harriers, which have changed most in character between 1982-97. Changes have also occurred on lower ground where a considerable area of semi natural vegetation, previously used by hunting harriers, has been lost to more intensive farming (ERM *pers obs*). One major change in Orkney agriculture has been the increasing numbers of sheep. In 1981 there were 31,164 breeding ewes in the islands; by 1996 this had risen to 55,541, an increase of 78% (Orkney Islands Council 1982 & 1998). These changes may have resulted in reduced food availability and could be one reason why some females apparently do not nest (Newton 1986, Simmons *et al* 1986) and others breed poorly.

Apparent non breeding amongst female harriers in the West Mainland was known during Picozzi's study and in 1981, for example, was estimated at 26% (Picozzi 1984b). Non breeding appeared to be particularly prevalent in 1996 (40%) and it is possible that such females may disrupt the breeding females. They certainly solicit males for food and copulation with some success (see also Simmons 1988 for Northern Harriers). Non breeding females may also attract predators, particularly Hooded Crows *Corvus corone cornix*, which were the main egg predators of Hen Harriers on Orkney during 1975-81 (Picozzi 1984a). Breeding corvids are abundant on Mainland and Hoy, and in addition flocks of up to 25 apparently non breeding Hooded Crows or Ravens *Corvus corax* were regularly seen on moorland during 1996 and 1997. These corvids were occasionally seen interacting with the apparently non breeding females in the vicinity of viable harrier nests.

Another factor affecting the population may be an increased mortality of males. Picozzi (1984b) suggested that polygyny in the West Mainland was a result of an imbalance in the sex ratio, possibly caused by a higher mortality of immature males. Observations at a winter roost on Orkney during 1975-81 suggested that more males than females left the islands in winter, possibly exposing themselves to greater risks (Picozzi & Cuthbert 1982). The winter dispersal of young male harriers from Orkney to the mainland of Scotland is presumably because suitable prey is more readily available there at that time (Watson 1977, Picozzi & Cuthbert 1982). The risks of leaving the islands might include lack of familiarity with their new habitat and the possibility of being deliberately killed (Scottish Raptor Study Groups 1997).

The extensive data sets have enabled us to quantify the alarming decline of the Hen Harrier in Orkney but detailed study is necessary to investigate its causes further.

Acknowledgements

We thank the many Orkney landowners who gave permission for access without which this work could not have been carried out. Mike Cockram, Nick Picozzi and Jim Williams gave us historical details for Eday, Rousay and East Mainland and Nick Picozzi and James Cadbury provided details of their West Mainland study areas. Dr Ian Bainbridge devised the protocol for the transect work. Dr Tom Prescott and James Plowman provided information from Hoy, Tim Dean and Peter Carty did likewise for Rousay and Tim Dunn, Ann Humble, Jim and Stuart Williams and David Wood assisted in the West Mainland. Dr Ian Bainbridge, Brian Etheridge, Dr Steve Redpath and Dr Ron Summers commented constructively on an earlier draft. Finally we thank Dr Mick Marquiss for statistical advice and for his helpful comments as referee.

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SHORT NOTES

Raven nest on hydro-electric dam

The Raven *Corvus corax* is known to nest on buildings, usually ruined, but there is only one record of a nest on a dam. This was on Glascarnoch Dam, Ross-shire, in the years 1970-73 (Ratcliffe D 1997, *The Raven,* Poyser. London). In late April 1996, I was told by the local landowner that a pair of Ravens had become very aggressive towards larger birds, such as Buzzards *Buteo buteo* and Common Gulls *Larus canus* flying over Errochty Dam, Perthshire and very vocal when people were walking the roadway surmounting the dam.

Investigation of the down stream side of the dam showed the ends of a few sticks projecting from the recesses of a ledge close to the top of the dam, and just below the roadway. Apparently identical ledges are found between the buttresses across the face of the dam, apart from the central over spill facility. Each ledge is widest at the buttress, narrowing to virtually no ledge at the centre of the inter buttress space. The particular ledge used by the Ravens was not the highest. The height of the dam decreases markedly towards the ends, as the dammed valley is steep sided. The ledge was just above the level of the tops of conifers growing on the slope below the dam. The parent birds perched on the tops of these trees, or on the dam parapet, calling loudly, while I was in the vicinity. I estimated the ledge to be 25-30m above ground level, and 2-3m below the parapet. It was impossible to see the actual nest, due to the lie of the land below the dam.

The Ravens raised 3 young in 1996. They used the site again in 1997, but the result is not known.

I thank Wendy Mattingley and Dr Mick Marquiss for helpful comments on an earlier draft of this note.

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Accepted March 1997

Juvenile Raven *David Mitchell*

Last breeding by native Red Kites in Scotland

The Red Kite *Milvus milvus* was found throughout much of Scotland during the first half of the Nineteenth Century, being present in all of Buchanan White's faunal districts except for the north and west coast archipelagos and east Dumbarton (Holloway 1995, *Historical Atlas of Breeding Birds in Britain and Ireland 1875-1900,* Poyser). It suffered heavily from persecution by both game preserving interests and collectors and, by the 1860s, it was confined to Inverness-shire, Perthshire and Aberdeenshire as a regular breeding bird (Gary 1871, *The Birds of the West of Scotland,* Murray), although still present in Ross-shire at this time, where Harvie-Brown and MacPherson (1904, *A Fauna of North-West Highlands and Skye,* David Douglas) had a record of a gamekeeper taking a clutch of eggs in 1883 and another record from 1881. The last proven breeding in Scotland was in Caithness in 1884; after this date it may have bred in Skye until 1886 although there is a very dubious record from Glen Garry (Inverness-shire) in 1917, where it had been seen in 1882 (Baxter & Rintoul, 1953, *The Birds of Scotland* Oliver & Boyd).

Major William Stirling of Fairburn (1858-1914) put together a substantial egg collection between 1895 and 1910, the eggs coming mainly from his own estate in Easter Ross and from neighbouring districts. In 1983, Captain Roderick Stirling, the collector's grandson, generously donated the substantial collection and documentation to Inverness Museum and Art Gallery. The collection has previously been referred to in McGhie 1994 (*Discovery of the first British clutch of Slavonian Grebe eggs in a museum collection, Scottish Birds* 17: 166-167), and McGhie and Moran 1996 (*Probable first breeding record of Brambling in Britain represented in a museum collection. Scottish Birds* 18: 248-249).

In the course of work on the Stirling collection we came across a clutch of 2 eggs with a slip of paper which contained the following information:
"Locality and Situation of the Fish tailed Glede On a summit in the Corry Done Craig, Kintail, Ross Shire. Date April 16th 1898".

The eggs measure 56.20 x 47.65mm and 54.45 x 46.60mm and agree well with descriptions of Red Kite eggs and other specimens in the collections; Fish tailed Glede is an alternative name for the Red Kite. The name Corry Done Craig cannot be traced with certainty, but there is a Choire Dhomdain (NG9915) in Kintail which is spelt Coire Dhuinnid on a 1905 OS map. The clutch size and date are in agreement with observations from Wales (*Birds of the Western Palearctic).* The species was at the least extremely rare by the time of the 1904 *Fauna* and Harvie-Brown thought it extinct; this clutch of eggs therefore represent, the last proven breeding record of Red Kite in Scotland. The last records Harvie-Brown had for the west Highlands were from 1883: a note stating '3 eggs. Nest placed on a rock called ....., Ross-shire 16th May 1883', and a note from Buckley of a pair supposedly nesting on an inaccessible rock in the Loch Carron district in 1881. Kintail is adjacent to the Loch Carron district, and either of these 2 records may even refer to 'Corry Done Craig'. Nesting on crags was certainly more unusual than nesting in trees but Harvie-Brown and Buckley (1895, *A Fauna of the Moray Basin,* David Douglas) record 2 instances other than those already mentioned: Harvie-Brown supposed that they nested on a rock at the outflow of Loch Garry and records that Booth had a record of birds

nesting on a crag in Rothiemurchus. Harvie-Brown, writing in 1895, did not know of any Red Kites anywhere in Scotland and was saddened by the relentless persecution which they had suffered, particularly at the hands of collectors.

We thank Captain Roderick Stirling for reading a draft of this short note and for his donation of his grandfather's important collection to Inverness Museum and Art Gallery.

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Accepted April 1998

Black Guillemot nesting on an operational car ferry

Black Guillemots *Cepphus grylle* breed in a range of natural sites. In addition, they have taken to a wide variety of artificial sites, including holes in breakwaters, harbour walls, piers, wharf buildings, under fish boxes and other debris (Harris & Birkhead 1985, Breeding Ecology of the Atlantic Alcidae, in *The Atlantic Alcidae,* Academic Press, Cramp 1985, *Birds of the Western Palearctic* Vol. 4). Harris and Birkhead consider that they "virtually always accept artificial sites if those are offered".

On 5 June 1992 while on the relatively short ferry crossing from Tayinloan, Kintyre to the Isle of Gigha in Argyll, I observed a Black Guillemot flying close to the car ferry *MV Bruernish.* The bird completed one circuit of the ferry, then approached the left side from the rear and landed on the moving ship, through a hole that carries the anchor chain, close to the bow. The bird remained on board until the ship approached the slipway on Gigha; when about 300m away, it flew off and to the rear, landing on the sea some 500m offshore. While the ferry was returning to Tayinloan, the Black Guillemot was observed flying around the ferry once it had left the slipway and had reached c300m offshore. As before, once the bird had flown around the ferry it landed through the same hole as previously. On 2 further occasions, when the ferry approached and left the Gigha slipway, this pattern of behaviour was repeated. The continued attraction of the ferry to an individual Black Guillemot raised the possibility of nesting on board.

On the return crossing, I examined the area close to the anchor chain hole and discovered a nest with 2 eggs under a green pvc cover amongst a range of winching machinery.

Before disembarking, I alerted the crew to the presence of the nest. They were already aware of the nest and told me that the birds had nested in the same place for the previous 2 or 3 seasons but had always been unsuccessful in hatching the eggs. I learned

later that the 1992 nesting attempt was also unsuccessful. During its normal operating hours (07.20-18.00hrs), the ferry undertakes 59 return trips each week. It is probable that in any one 20 minute sailing only 15 minutes were available for incubation, and that during the ferry's turn around period of c15 min the birds were unable to incubate. On the 6 operational days per week, this would limit incubation to a maximum of 4.5 hours between 07.20-18.00hrs, losing 25% of available incubating time during the entire incubation period ie incubation would be limited to a maximum of 75% of the available time. This compares with the incubation taking 84% of available time (Preston 1968 cited in Cramp 1985). However, in this case, either the limitation of time or the frequency of disturbance, or a combination of both, appears to have prevented the eggs from hatching.

At the end of the 1992 summer season the operators replaced the *Bruernish* with another, larger ferry of a different design. In subsequent years, the birds have not attempted to nest on the new ferry.

While this car ferry represents an extraordinary nesting site, it does not appear to be unique. Thom (1986, *Birds in Scotland,* Poyser) records "a niche on an inter island ferry in Shetland" and Tulloch (1992, *A Guide to Shetland's Birds.* Shetland Times, Lerwick). *comments "It has even been recorded nesting under a life raft on the stem of a regularly used ferry boat" [The comment was made by Bobby Tulloch*]

I would be interested to see further information on these records.

Chris M Waltho, 73 Stewart Street. Carluke, Lanarkshire, ML8 5BY

Revised manuscript accepted May 1998

Hen Harriers cacheing and retrieving prey

Many raptors regularly and purposively store avian prey for later use in the breeding season (Cramp & Simmons 1980, *The Birds of the Western Palearctic* Vol 2 Oxford). Information on Hen Harriers *Circus cyaneus* cacheing prey is generally lacking and, despite intensive studies of harriers since 1963, I have only 2 instances of it.

On 14 July 1974 at 0957 hours I watched a female Hen Harrier return to its breeding area in Wigtownshire carrying a young Curlew *Numenius arquata.* She landed on a heathery knowe 100-200m from her nest, and emerged without the prey. She landed briefly at the nest, which contained 3 young about 18-24 days old, before taking off and landing on the moor well below the nest site. Thirty nine minutes later, the female harrier flew back to where she had deposited her prey. She circled there with lowered talons, flew back to her

nest and hovered above it. She flew back to the cached prey, retrieved it and brought it back to the nest at 1040hrs, leaving with the remains 24 minutes later.

On 17 July 1974 at 1800hrs the same female stood on the moor below the nest. She flew to the heather knowe, dropped her talons and again retrieved small to medium sized prey from the heather and flew back to the nest with it. Despite several later visits this behaviour was not seen again.

Purposeful storage of 'surplus' prey by raptors is usually of prey brought by the male to the female who usually stores it. Interestingly, it was a large prey item, apparently caught by the female herself and then purposely stored by her. Cacheing behaviour becomes more advantageous if the food is less likely to spoil (Heinrich 1990, *Ravens in winter*, London). In one of the instances the prey was used quickly (within 43 minutes of storage) and in the other it may have been used quickly too.

R C Dickson, Lismore, New Luce, Newton Stewart, Wigtownshire DG8 0AJ

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Ravens nesting successfully on a specially provided platform

In June 1996 I received a report that a pair of Ravens *Corvus corax* had attempted to nest in the barn of a ruined croft in the West Mainland of Orkney. The croft was situated in an area of grassland used for cattle and sheep grazing. I visited the barn and found the semblance of a nest lying across a roof beam at a height of about 4 metres. The structure consisted of sticks, lengths of barbed wire, part of a lamb skeleton and pieces of wool. The beam was only 5cms wide and the materials were draped over it. It would have been impossible for such a narrow beam to have supported a complete Raven's nest. It then occurred to me that a platform placed across 2 of the roof beams, which were 1.5 metres apart, would make a suitable base for a nest.

I contacted the farmer who owned the barn suggesting that a platform could be put in the roof and he was delighted with the idea and of possibly having a pair of Ravens nesting successfully on his land. The covering of the roof consisted of sheets of rather rusty corrugated iron, many of which were missing and several others were loose. It was decided to delay putting the platform in position until after the winter, in case more sheets were lost or the platform blown away. Unfortunately, it was not actually in place until 8 March, 1997, which was rather late for the Raven's nesting season. However, on returning to the

barn 2 months later it was found that the foundation of a nest had been built on the platform but the lining had not been completed.

I next visited the barn on 9 April 1998 and, as I entered the building, flushed a Raven from a fairly substantial nest that was on the platform. The bird flew around calling agitatedly so I left as quickly as possible without examining the nest any further. On 5 May 1998 there were 4 full grown young standing on the nest and a week later the young were seen perched on the roof of the barn.

Ravens had been observed in the vicinity of this croft several times in the breeding season over the past 10 years and I had been to the site on 2 previous occasions but had not found any evidence of nesting. A pair of Ravens have nested successfully for a number of years, including 1998, on a ruined building 3.5 kms from this croft.

I am very grateful to Bob Adam for his help with the building and placing of the platform in position and to Steven Harvey for allowing access to his barn.

C J Booth, 34 High Street, Kirkwall, Orkney, KW15 1AZ

Manuscript accepted September 1998

Proposals to extend the range of the Crested Tit in Scotland, 1945-1955

Historical research has revealed some interesting observations on early proposed nature conservation practices in relation to the Crested Tit *Parus cristatus scoticus* in Scotland, more particularly in Strathspey. It is apparent from the archives of the Nature Conservancy (NC) Scottish Committee which begin in April 1949, that an application was put before the committee on 7 December 1954 to transplant Crested Tits out of the Highlands to other parts of Scotland. The proposal was conceived by JMD 'nestbox' Mackenzie, a Forestry Commission employee, who was known for his nestbox work with ducks and flycatchers (P Sandeman *pers comm*). He sought to transplant the birds caught in Strathspey to 'suitable pine forests in Perthshire, Angus and Fife'. Mackenzie's declared aim was to extend the bird's range as a nature conservation strategy. The NC Scottish Committee seemed confused by this request, and decided to relay it to the Advisory Committee on the Protection of Birds (SRO:SNH 1-1, Minutes of meeting of Nature Conservancy – Scottish Committee, Edinburgh, 7 December 1954).

However, the issue remained alive, and the NC Scottish Committee returned to it at a later meeting in March 1955. This was the first committee meeting attended by JP Grant of Rothiemurchus, and he was keenly interested in a proposal that could see the transplantation of some of the tits from his own estate. The laird was against transplantation as a nature conservation practice, but saw some merit in the 'laudable' scheme 'of spreading the risk'. He praised Mackenzie's vision that could have guaranteed 'more areas that this rare bird frequented', thus ensuring there was less

'chance of it being wiped out by localised disturbances'. The feeling of the Scottish Committee was that this application could not be supported, but no firm reason was given (SRO:SNH 1-1, Minutes of meeting of Nature Conservation – Scottish Committee, Edinburgh, 3 March 1955). This episode is made all the more interesting by the fact the original application was probably drafted in Autumn 1954, just a matter of weeks before the new Protection of Birds Act passed into law on 1 December 1954. This was a powerful piece of new bird protection legislation that repealed 15 previous Acts and offered full protection to all wild birds, their eggs and nests, with some limited exception relating to game and vermin species. This discussion also came just after the declaration of the Cairngorms NNR on 9 July 1954, within which Rothiemurchus Estate, and thus its Crested Tits, was a key component. Information taken from other archives regarding the Crested Tit in the 1940s provides some background to this 1950s debate. The second half of the 1940s saw an intensification of the Cairngorms National Park and/or Nature Reserve debate, and the Crested Tit had a role to play in that. Baxter and Rintoul wrote in December 1945 to Joseph Westwood, the Secretary of State for Scotland, urging him to support the Nature Reserve ideal, adding that the Crested Tit demanded 'special care' because it was 'so typically Scottish and so very local in their breeding area' (SRO: FC9/3, Letter, dated 12 December 1945). The body that preceded the NC Scottish Committee, the Scottish Wild Life Conservation Committee (SWLCC) of 1946-1949, confronted issues surrounding the protection of the Crested Tit on a number of occasions. The most controversial event took place in 1946, when the SWLCC became angered on hearing that PA Clancey had been collecting Crested Tits in Strathspey, and was then taking them away 'for research purposes' (SRO:FC9/2, Minutes of meeting of SWLCC, Edinburgh, 30 September 1946). This was Philip Clancey, a worker in the museum service in Scotland and later in Durban, South Africa, who was known to have done taxonomic work on the races of some passerines (RH Dennis *pers comm*). This perhaps explains his interest in the Crested Tit, which we must assume he was taking away to skin and/or stuff. Clancey later built up a large collection of African birds in Durban museum. A year later, James Ritchie reported to the SWLCC that some felling of pinewoods at Rothiemurchus was continuing, and that 'adequate provision must be made for the protection of the Crested Tit' (SRO:FC9/3, Minutes of meeting of SWLCC, Edinburgh, 29 September 1947). The harsh winter of 1947 then adversely affected the Scottish tit population, although in the 1950s the Crested Tit did expand its range into Culbin Forest.

Primary sources

SRO: SNH are the archives of the Nature Conservancy and Nature Conservancy Council in Scotland, held in the Scottish Record Office, Edinburgh.

SRO: FC are the archives of the Forestry Commission in Scotland, held in the Scottish Record Office, Edinburgh.

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LETTERS

Numbers of Turnstones and Purple Sandpipers on the East Lothian Coast

In H E M Dott's paper on declines in Turnstones and Purple Sandpipers in S E Scotland (*Scottish Birds* 19:101-14), there is a table with the maximum counts of the latter species at Gullane Point – Hummel Rocks in East Lothian. For the record, Keith Macgregor and I had peak counts at this site of 20 in 1952-53; 24 in 1953-54; and 20 in 1954-55. These counts are much in line with the last 8 winters on Table 2 (p 103), made between 1987-88 and 1994-95. It is nice to know we were not just enjoying ourselves in the 1950s.

Frank Hamilton, 23 Campbell Road, Longniddry, East Lothian EH32 0NP

Received February 1998

Comment by H E M Dott

On 31 January 1998, a further low tide count was made of all shore birds from Gullane Point to the Scotland/England border; the same coast with the same methods and by mainly the same people described in Dott 1997 (*Scottish Birds* 19: 101-104). Results obtained for the species concerned were:

Turnstone 264
(East Lothian - 233, Borders - 31)
Purple Sandpiper 81
(East Lothian - 66, Borders - 15)

This again shows continuing very low numbers in the 1990s compared to the much higher numbers in the 1970s and 1980s, as previously described.

H E M Dott, 114 Comiston Road, Edinburgh EH10 5QL

Received July 1998

OBITUARIES

Valerie MacLaren Thom

1929-1998

Valerie Thom made a massive contribution to natural history in Scotland. She will be best remembered, probably, for her *Birds in Scotland*; recognition tends to go to major publications of that kind, as it also does to large personalities and high profile projects and research.

But the remarkable extent to which the amateur (and professional) study of wildlife in Scotland has expanded and flourished since the War could simply not have happened without the largely unseen and wholly unsung infrastructure of committees, councils, record keeping, policy making, financial accounting, journal editing, collating of information, and organising of volunteers. It is in all of this that she had an outstanding role, and made perhaps her largest contribution.

Born in Tynemouth, Northumberland in 1929, Valerie graduated BSc in Agriculture at Edinburgh University in 1949, taking the first year medal. She went to work in the East of Scotland College of Agriculture and earned high professional respect for her work connected with the quality of milk.

In 1969 she changed direction and joined the newly established Countryside Commission for Scotland where she worked for a dozen years before taking early retirement. Here she was involved in pioneering work in countryside interpretation in a team led by Don Aldridge who defined it as 'the art of explaining the significance of a site to the people who visit it, with a view to pointing a conservation message'.

Though taken for granted nowadays, this was then a novel concept, originating in America, combining information, enjoyment and a homily. It involved educating not only the public but also the agencies, local authorities and voluntary bodies providing much of that education. Valerie worked tirelessly to set and raise standards of presentation in texts and pictures, and especially in the spoken word of the new ranger services, at a time when visitor centres and other facilities were springing up all over the country, not always ideally located or focussed.

The experience she gained in this was invaluable to the fledgling Scottish Wildlife Trust of which she chaired the Perth branch, and which was setting up interpretive services at its reserves at the Falls of Clyde and at the Loch of Lowes with its second most famous pair of Ospreys. Not that she ignored the most famous pair, lending a hand during a number of summers at the Royal Society for the Protection of Birds Loch Garten reserve, relishing the sights and sounds of the neighbouring ancient pine forests.

She helped the RSPB in other ways too, serving on its Scottish Committee with advice which her colleagues remember as always wise and carefully thought through. This thoroughness also served well the bureaucratic complexities of the Secretary of State for Scotland's Advisory Committee on Birds, and the wide-ranging collaborative research projects overseen by the Council of the British Trust for Ornithology, on both of which she sat in the 1970s.

Earlier, she had been Secretary and Chairman of the Ornithological Section of the Perthshire Society of Natural Science from 1965 to 1972 and had found, or made, time to be the

Wildfowl Count organiser for Scotland for the Wildfowl and Wetlands Trust from 1963 to 1970. This involved the pleasure, keenly felt, of counting the geese on a frosty, clear winter day at her local Dupplin Loch near Perth, but also carrying through the counts in foul weather as well, and meticulously correlating the efforts of many others. They soon learned that she was stickler for detail. Everything had to be *right*.

As it had to be, too, in her work for the Fair Isle Bird Observatory Trust. To use her own word she became 'addicted' to the island when she worked there for a season in 1955 as the observatory's first assistant warden. For 23 years from 1970 she was one of its Trustees and for six of them, from 1986 to 1992, its Honorary Secretary. What a deal of work there was in that, and what a valuable job she did in acting as a link between a scattered Board of Trustees and the observatory staff, with her great knowledge of the island she loved and its community. She was able to make good use of this knowledge in drawing together the work started by George and Irene Waterston in gathering material for a history of Fair Isle and which she completed in *Fair Isle, An Island Saga*, published in 1989.

Throughout all these years, Valerie was an extremely active member of the Scottish Ornithologists' Club, serving on and chairing several of its committees, and in 1978 she was elected its President. These were good years for the SOC with flourishing branches, revenue surpluses, bookshop sales rising by 25% or more a year, and no hint yet of the maintenance problems at 21 Regent Terrace. In her crisp and business-like way Valerie chaired Council meetings which galvanised the Scottish Bird Report (running three years late when she took over) and pondered such issues and threats to bird life as the Torness power lines and the Lurchers Gully skiing development.

In her last year as President, Council took the decision to go ahead with a new book on the status of the birds of Scotland, which she volunteered to write. Thirty years after *The Birds of Scotland* by Dr Baxter and Miss Rintoul (to this day scarcely anyone refers to their first names) the 'good ladies' mantle would be handed down to Valerie Thom in a wholly appropriate way. The new book was partly financed by the entire remaining funds in the Baxter and Rintoul Trusts.

It was an enormous task to undertake and it took five years. During almost all of this time Valerie also edited both *Scottish Birds* and *Scottish Bird News*, a formidable and unenviable combination. The new book drew on the willing assistance of many members of the Club, both in providing and dealing with material; some 150 of them are listed in the acknowledgements. So it was a collaborative venture from the start, but at centre it was Valerie's achievement. *Birds in Scotland* was published in 1986 and is her enduring memorial. In that same year she was elected Honorary President of the SOC.

These were some of her public achievements, but Valerie was a very private person, reserved and not easy to get to know. She was impatient of small talk and could be nippit with people whose standards of commitment and performance were less exacting than those she set for herself. Some people found her slightly daunting.

She was, though, a deeply compassionate and caring person, drawing strength and conviction from her Christian faith. Her minister in Perth recalls her saying to him:

"I've been given this gift of faith. I know I have certain talents. I have the energy. I want to do things for my Lord." Ordained as an elder in the Church of Scotland, she took a two year theological course and cared faithfully and patiently for the people in her district and also cared, in different ways, for fellow believers in the former Soviet bloc countries. She devoted a great deal of time to Manna House in Perth, a coffee house and meeting place whose Christian witness proclaims the Gospel in the market place, and to establishing a pastoral care group.

She had a great love for the Scottish countryside, its wild places and its birds. Perhaps both her joy in them and her concern for them are summed up in two verses from her poem published in *Birds in Scotland*:

An eagle soaring high on a thermal,
A peregrine swooping swift to the kill,
Divers wailing on lonely lochans –
Such sights and sounds have the power to thrill.

The "everyday" birds such as Wren and Robin
And the rarities blown here from distant lands
All have their place in God's great pattern –
But the future for many will lie in man's hands.

John Arnott

Valerie Thom pictured cutting the cake at the launch of Birds in Scotland in Glasgow, 1986

John Morton Boyd

1925-1998

Morton Boyd, who died on 25 August 1998 at the age of 73, was one of Scotland's best known ecologists and wildlife conservationists. He was born in Darvel, Ayrshire on 31 January 1925. He attended Kilmarnock Academy and then went to Glasgow University to study engineering. However, after one year he read Frank Fraser Darling's book *A Naturalist on Rona* (1939), and as a result he changed from engineering to zoology. Service in the RAF interrupted his education but he graduated in 1953, obtained a PhD degree in 1957 and a DSc in 1964, followed eventually about 30 years later, again at Glasgow University, by a D Litt, a very rare recognition for a scientist. He was also awarded the Neill prize of the Royal Society of Edinburgh. Morton was a broadly based naturalist and, though his main interests were birds and mammals, he studied earthworms on Tiree for his PhD, the start of a long affection for this island. The great diversity of his interests established a fervour for ecology and land use of the Western Highlands and Islands. In all these topics he was a great communicator; to the end, however, Morton hadn't quite mastered the art of sharing conversation and seldom used one word when 10 would do.

He was a long standing member of the Scottish Ornithologists' Club. He made a substantial contribution to our knowledge of the birds of Scotland, notably by his studies on St Kilda. The report *Birds of St Kilda* (Harris & Murray 1977) lists 11 papers of which Morton was author, including 2 important papers on seabirds. These were *Distribution and numbers of kittiwakes and guillemots* (*British Birds* 1960) and *The gannetry of St Kilda* (*Journal of Animal Ecology* 1961). Fieldwork for it began in May 1955 when Morton, in a motor drifter, sailed close by Stac Lee and Boreray, allowing him his first impression of the immense scale of the cliffs and the great numbers of birds there. He returned the following year with an expedition from Glasgow University. On 13 May 1959 the RAF photographed the entire gannetry from the air, with Morton together with Derek Ratcliffe and David Boddington watching from the top of Stac an Armin. Thereafter, Morton's task was to count the Gannets on the photographs, and he did this 4 times! Then he divided the gannetry into 672 sections, assessed the overlaps between pictures and concluded that the population was 44,500 pairs. Diagrams of the main counting areas and the details of the actual counts are given in the paper which became a benchmark. It was almost 30 years before the St Kilda Gannets were counted for a second time.

Morton was one of the first scientists to be recruited to the Nature Conservancy in Scotland and he was appointed in 1957-68 as regional officer in charge of wildlife conservation in the west of Scotland. He was instrumental in establishing several national nature reserves and will long be associated with the Grey Seals of North Rona as well as the sheep and Gannets of St Kilda. The 1950s and 1960s were happy days for ecologists in Scotland; those on the staff of the Nature Conservancy were able to indulge their interests virtually unhindered. Morton led many expeditions to his favourite islands at home and abroad, and initiated long term studies on the sheep on Soay and Boreray and the seals of the Hebridean Islands, often in very difficult field conditions. With his family, he spent many idyllic holidays on Tiree where, from his deep seated interest in wildlife, land use and social customs, he gained the impetus to write 4 books on the Hebrides, one co authored with his son, Ian. Morton

also worked with Ken Williamson with whom he co authored *St Kilda Summer* (1960). In Morton's obituary in the *West Highland Free Press* (11 September 1998), Brian Wilson records how Morton and Williamson prevented the army, set on making a road, from demolishing the remains of the row of houses on Hirta. This would have been 'an act of almost unbelievable vandalism'.

Morton was supportive of a range of investigations in the north west and notably encouraged Jim Lockie in early work on Pine Martens, Niall Campbell with a study of Sticklebacks and Dick Balharry's studies of Golden Eagle and Pine Martens. Ian Newton remembers with gratitude Morton's encouragement of his early work on Greylag Geese at Loch Druidibeg. In his appreciation in *The Scotsman* (10 September 1998) John Francis, Morton's successor, mentions the reintroduction of the Sea Eagle as a part of Morton Boyd's legacy. Francis recalls Morton's stories of the early days of the Loch Ewe partnership, and in particular those about a Red Deer stag called Iain which 'are among the richest brand of humour imaginable'. This partnership culminated with the first successful deer management group.

Morton was Assistant Directory (Conservation) of the Nature Conservancy (Scotland) in 1968-70 and became Director of the Nature Conservancy (later Nature Conservancy Council Scotland) from 1971 to 1985. He took over in a period of relative calm but shortly the peace was to be shattered. Suddenly the Nature Conservancy as designed by Max Nicholson, with national headquarters in London, Edinburgh and Bangor and research stations at Monkswod, Merlewood, Furzebrook, Norwich and Banchory, was divided. Hitherto, conservation managers and research workers had shared office accommodation and this synergy stimulated dialogue and worked well. In 1972, following the Rothschild report on the organisation of government science, the Nature Conservancy Council was formed. The research arm was removed from the Conservancy to the Institute of Terrestrial Ecology and, as a result, Morton lost authority over research staff in Edinburgh. Shortly afterwards, decentralisation from Edinburgh took place with regional officers outposted to local offices. The reorganisation demanded considerable resilience and Morton thrived on it. The implementation of The Wildlife and Countryside Act (1981) closely monitored from NCC's Peterborough HQ and reinforced by voluntary organisations and parliamentary scrutiny, disrupted the non confrontational style that had characterised NCC's relationships in Scotland with the powerful lobbies of landowners, foresters and farmers since the 1950s.

In this new climate, some of Morton's dedicated local staff, supported directly by NCC's largely English based Chief Scientists's Team, were able to achieve significant protection for important wildlife sites in the face of the kind of development pressures before which the NC had caved in during previous decades. The first half of the 1980s saw notable successes for conservation across Scotland: in Islay (with its goose problems); in the Northern Isles; in Speyside (Creag Meagaidh, the Cairngorms northern corries and Abernethy); and in the bird rich Flow Country in Caithness and Sutherland. Many of these victories were achieved in the face of opposition from more traditional sections of the Scottish land owning community and perhaps from the Scottish Office itself. Nothing demonstrates better Morton's character and his commitment to nature conservation than his reluctance to bow to these pressures. His steadfastness and that of his staff in circumstances in which

they were occasionally subjected to personal abuse safeguarded numerous important wildlife sites and secured long term and positive shifts in attitudes to conservation in Scotland.

However, there was a price to pay for the period of conflict that was necessary to secure this legacy. Shortly after Morton's retirement in 1985 and the subsequent 5 year period under the leadership of John Francis, NCC was dismembered as a Great Britain wide body leading, with its amalgamation with the Countryside Commission for Scotland, to the creation of Scottish Natural Heritage which was under Scottish control. SNH is a very different kind of organisation; it espouses access and partnerships, not the strenuous defence of nature conservation interests, and has been known to attack the scientific emphasis of its predecessor. Nonetheless Morton, said by Brian Wilson to be a devolutionist, accepted these political changes and worked positively with his successors for wildlife conservation in Scotland. Morton and John Francis were the last scientific directors of nature conservation in the Berry/Eggeling tradition and, although the organisation which Morton led for 14 years scored major successes in a hostile political environment, it paid a heavy price for its achievements.

Morton travelled widely, both as a professional ecologist in the 1960s and also more recently leading safaris and lecturing on cruises, notably those organised by the National Trust for Scotland to the outer isles and by Swan (Hellenics) Ltd and Serenissima Travel Ltd to the Mediterranean Sea, Indian Ocean, Indonesia and Africa.

After retiring, when his contributions were acknowledged by his CBE, Morton seemed to live anew. He became ecological consultant to bodies such as North Scotland Hydro Electric and to the Forestry Commission, and worked with the National Trust for Scotland, as councillor for the Royal Zoological Society of Scotland, editorial consultant for Edinburgh University Press and for Mirror Publications Ltd, and became a vice president of the Scottish Wildlife Trust and the Scottish Conservation Projects Trust. He was committed to the Saltire Society and an active committee member of the Royal Society of Edinburgh, and a trustee of the Hebridean Whale and Dolphin Trust. He was accomplished in water colours and, by coincidence, he completed the design of the Colinton Kirk Christmas card on the Saturday before he died.

In spite of all his outside interests, Morton had at heart 2 outstanding passions, his family and the community of Colinton parish kirk. For 40 years he was an elder. He was devoted to his wife, Winifred, who suffers greatly from arthritis in her hips, and he was very proud of his sons, their wives and children and also activities. They were a constant source of support.

In 1997 Morton agreed to be Patron of Dunbar's John Muir Association. Muir and Morton, both sons of Scotland, were 2 of a kind. They were free spirits and expressed with frisson the causes they chose to champion, a course that had its dangers. Few who knew Morton will forget his contributions and his energy, charm and affection, an enduring and endearing testimony.

David Jenkins

The author thanks for their contributions John Forster, Mike Harris, Fred Last, Jim McCarthy, Sarah Wanless and the authors of published obituaries cited in the text.

Advice to contributors

Authors should bear in mind that only a small proportion of the *Scottish Birds* readership are scientists, and should aim to present their material concisely, interestingly and clearly. Unfamiliar technical terms and symbols should be avoided wherever possible and, if deemed essential, should be explained. Supporting statistics should be kept to a minimum. All papers and short notes are accepted on the understanding that they have not been offered for publication elsewhere and that they will be subject to editing. Papers will be acknowledged on receipt and will be reviewed by at least 2 members of the editorial panel and, in most cases, also by an independent referee. They will normally be published in order of acceptance of fully revised manuscripts. The editor will be happy to advise authors on the preparation of papers.

Reference should be made to the most recent issues of ***Scottish Birds*** for guidance on style of presentation, use of capitals, form of references, etc. **Papers should be typed on one side of the paper only, double spaced and with wide margins and of good quality; 2 copies are required and the author should also retain one.** We are happy to accept papers on computer discs; however, please state the type of word processing programme used. Contact Sylvia Laing on 0131 556 6042 if you wish further information on this. Headings should not be underlined, nor typed entirely in capitals. Scientific names in italics should normally follow the first text reference to each species unless all can be incorporated into a table. Names of birds should follow the official Scottish list (*Scottish Birds* Vol 17:146-159). Only single quotation marks should be used throughout. Numbers should be written as numerals except for one and the start of sentences. Avoid hyphens except where essential eg in bird names. Dates should be written:...on 5 August 1991.....but not on the 5th (if the name of the month does not follow). Please do not use headers, footers and page numbers. Please note that papers shorter than c700 words will be treated as short notes, where all references should be incorporated into the text, and not listed at the end, as in full papers.

Tables, maps and diagrams should be designed to fit either a single column or the full page width. Tables should be self explanatory and headings should be kept as simple as possible, with footnotes used to provide extra details where necessary. Each table should be on a separate sheet. Maps and diagrams should be either good quality computer print outs in black and white (please do not use greyscale shading) or in black ink and be camera ready, but drawn so as to permit reduction from their original size.

Scottish Birds

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